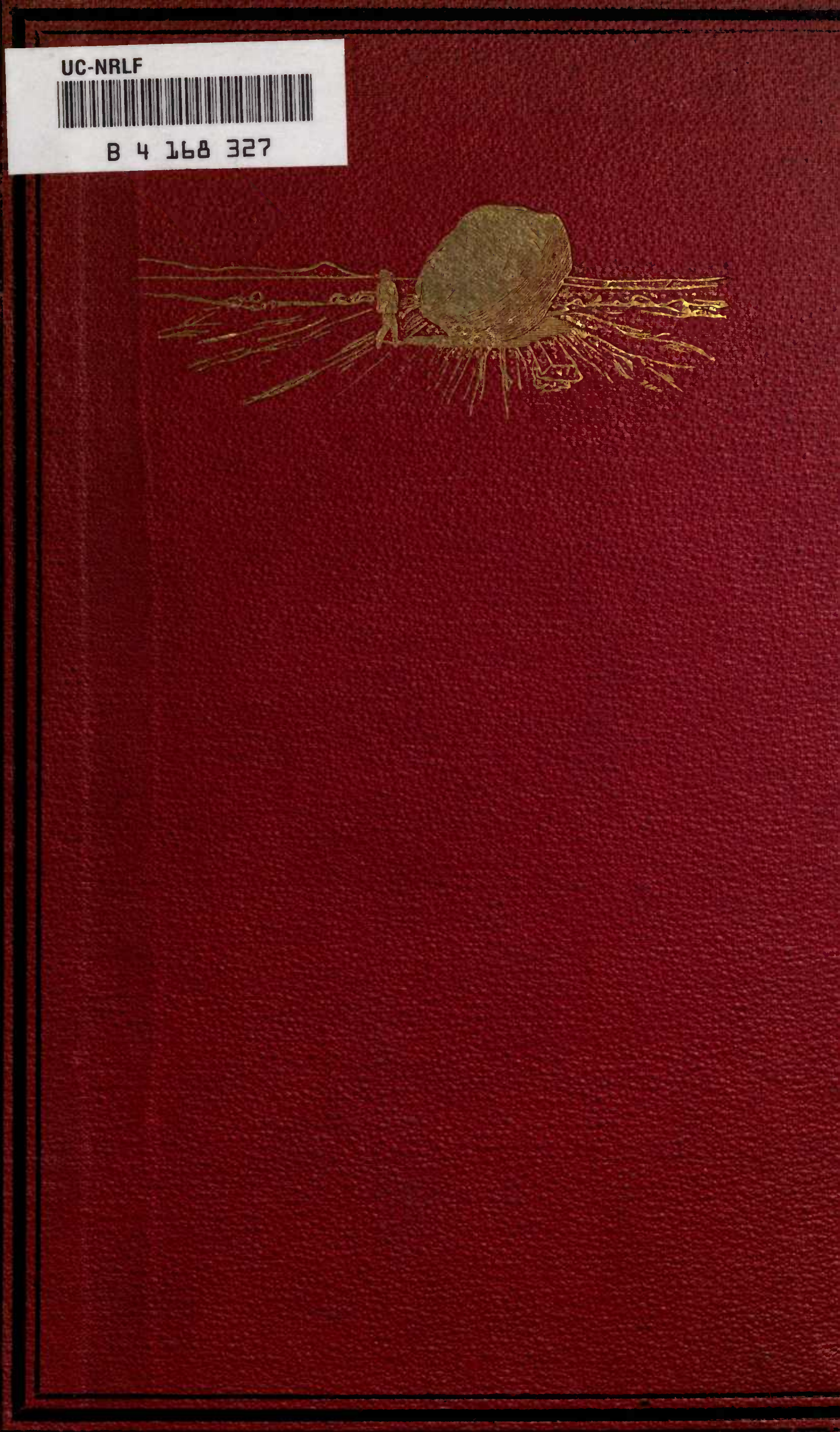
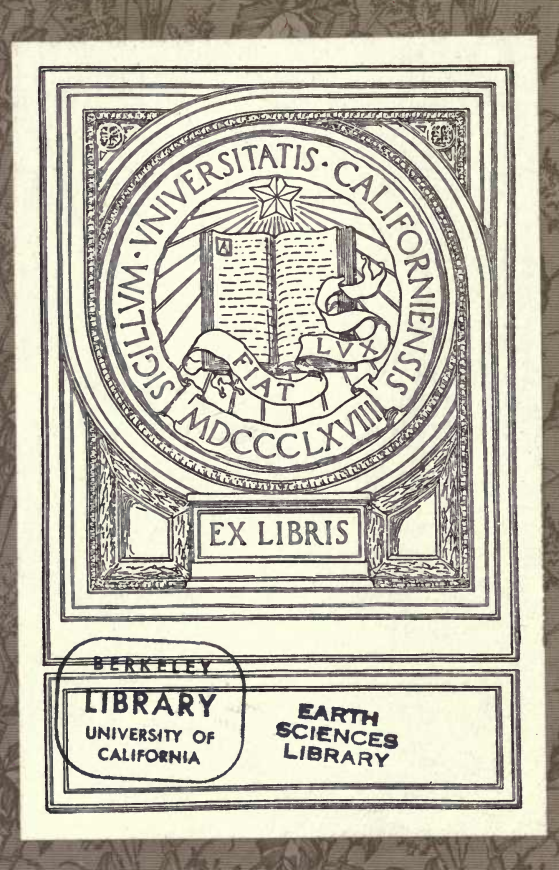

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Principal Grant
with the author's kind regards.

LIFE

OF

SIR WILLIAM E. LOGAN, Kt.



Yours truly
W. E. Logan

LIFE

OF

SIR WILLIAM E. LOGAN, Kt.,

LL.D., F.R.S., F.G.S., &c.,

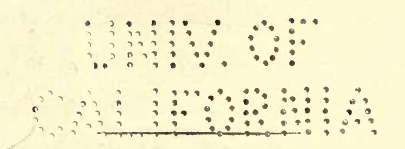
FIRST DIRECTOR OF THE GEOLOGICAL SURVEY
OF CANADA.

Chiefly Compiled from his Letters, Journals and Reports.

BY

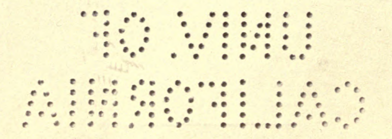
BERNARD J. HARRINGTON, B.A., Ph. D.,

PROFESSOR OF MINING IN M'GILL UNIVERSITY ; LATE CHEMIST AND MINERALOGIST
TO THE GEOLOGICAL SURVEY OF CANADA.



WITH STEEL PORTRAIT AND NUMEROUS WOOD-CUTS.

MONTREAL
DAWSON BROTHERS, PUBLISHERS.
1883



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PREFACE.

THE task of preparing a biography of Sir William Logan was not a self-imposed one, and was only undertaken with feelings of great delicacy. There are those who knew him longer and more intimately, and who might have done far better justice to his memory. But the work having been entrusted to me, I have endeavoured to discharge it faithfully. My aim has not been to write a eulogium or yet a lengthy criticism of Sir William, but rather to bring together such of his own words as will recall him to the minds and hearts of old friends, or enable those who were not privileged with his acquaintance to form for themselves an estimate of his character and work.

Canadians cannot afford to forget the name of one who laboured so long and so earnestly to promote the interests of this his native land, and if the following pages in any way serve to keep green the memory of Sir William Logan, their compiler will feel more than repaid. We have plenty of Canadians able and willing

to work for themselves, but too few who, like Logan, are willing to work for Canada.

My grateful acknowledgments are due to Professor Geikie, now Director-General of the British Geological Survey, for information incorporated in the text; to Alexander Murray, Esq., C.M.G., Director of the Geological Survey of Newfoundland, for reminiscences of Sir William; to Dr. John Percy, F.R.S., of London, for his estimate of Sir William's work; to Mr. J. Gwyn Jeffreys, F.R.S., for the reminiscences given on page 388; and to Dr. T. Sterry Hunt, who has kindly given me the benefit of his advice on a number of points about which I was in doubt. I would also express my indebtedness to Dr. Dawson, for notes on the origin of coal, for the use of a number of wood-cuts, and for his article on the Quebec Group. The latter was kindly prepared by him to serve for my assistance and guidance; but I was unwilling to mutilate it, and with his permission have given it in full as an Appendix (A). My sincere thanks are due to Dr. Selwyn, Sir William's successor, for the use of note-books and of a number of wood-cuts; to Mr. G. R. Grant, one of Sir William's executors, for his unvarying courtesy and kindness in placing at my disposal letters, journals, etc.; and, among others, to my friend Professor C. E. Moyse, of McGill College, for advice and assistance in revising the proof sheets of the earlier chapters

The information concerning the origin of the Geological Survey of Canada is chiefly derived from Scobie's Almanac. Most of the illustrations scattered through the volume are copies of pen-and-ink sketches with which the pages of Sir William's note-books and journals abound. They have been reproduced on wood by Mr. W. H. Walker, of Montreal. The steel portrait forming the frontispiece is from a photograph by Notman, taken in 1869. It represents Sir William in his graver moments, and fails to give an idea of the humour and brightness which so often pervaded his countenance.

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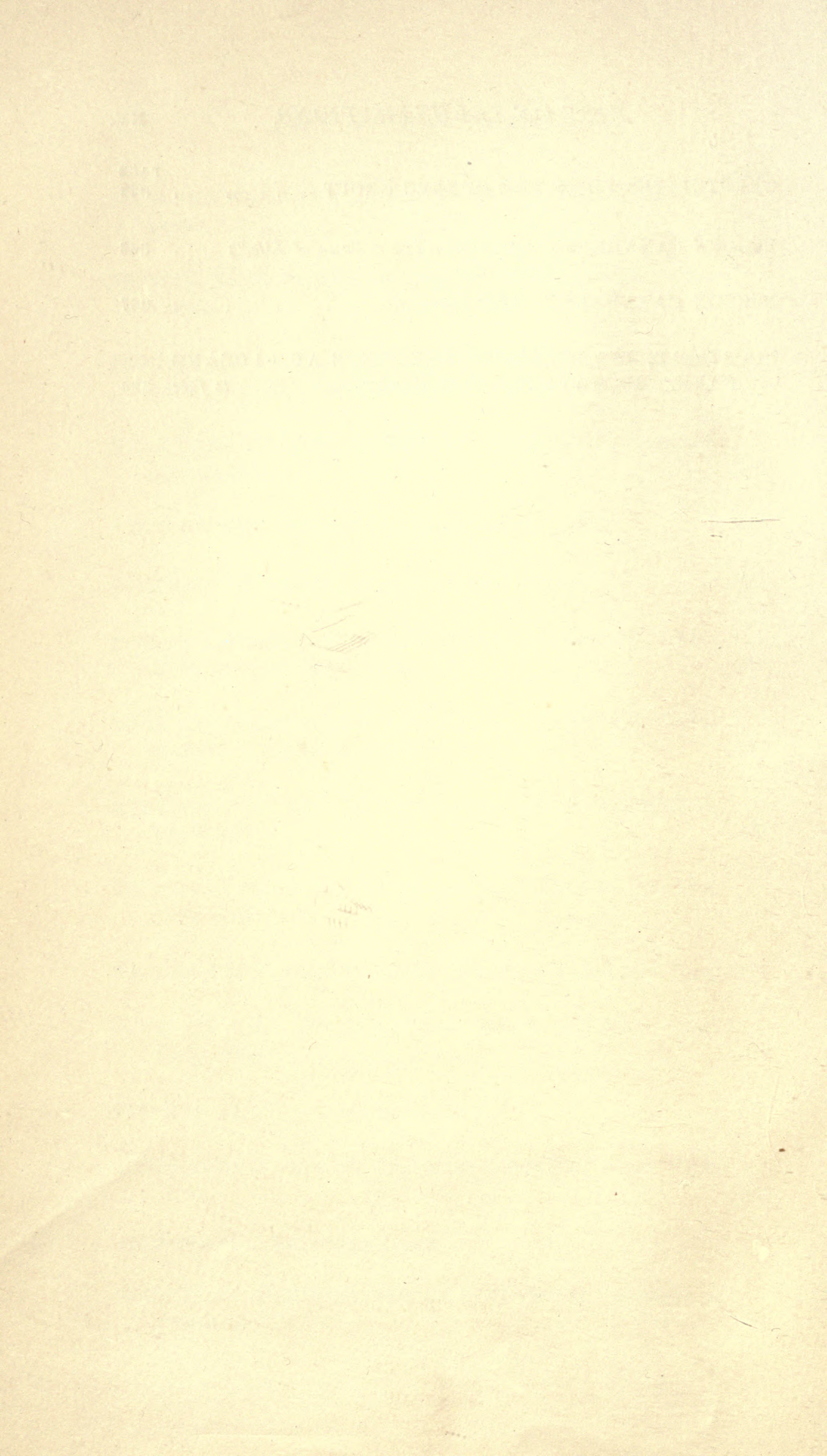
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CHAPTER I.

BIRTH AND BOYHOOD.

IN the County and Parish of Stirling, not far from the old Castle of that name, there lived, more than a century ago, one James Logan. He was married to Miss Margaret Edmond of the same neighbourhood, and between 1756 and 1772 she bore him six sons and three daughters. But death made sad inroads upon his household, taking one after another of his little ones from him, until but two sons and two daughters remained. William, the elder of the surviving sons, was born in the Parish of Stirling on the twenty-fourth of September, 1759, while Hart, the youngest of the family, was born on the twelfth of January, 1772. According to the records of the Parish of Stirling, the father was a burgess, and followed the calling of "baxter," or baker. But, like many other Scotchmen, he thought to better his fortunes in the New World, and, taking his wife and two sons with him, sailed for America, probably about 1784. He found his way to Montreal, established a large bakery there, and, with wise forethought, purchased considerable property in

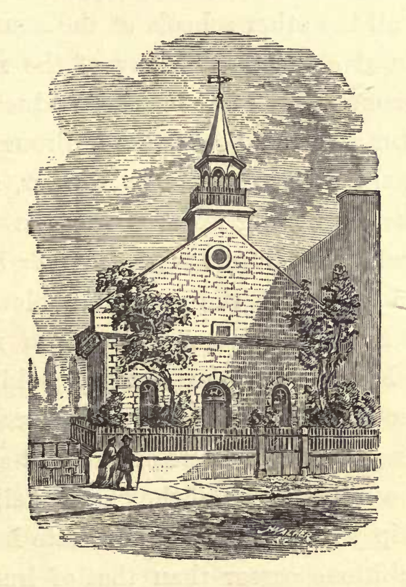
the vicinity of the city. In the last decade of the century we find him comfortably settled on his farm, his elder son managing the bakery, while the younger was carrying on a prosperous importing trade.*

In the spring of 1794, Miss Janet E. Edmond, of "Conniehill," near Stirling, niece of Mrs. James Logan, left her Scottish home, and more than one admiring suitor, for Canada. Hither she came to be married to her cousin, Mr. William Logan. Years before they had been more than friends in the old country, and now were to be more than lovers in the new. Husband and wife, father and mother, the time-honoured sequence was theirs, and, as years rolled on, they became the parents of nine children, five sons and four daughters. The third child, the subject of the present memoir, was born at Montreal on the 20th. of April, 1798, duly "inoculated for small-pox," and christened as William Edmond Logan on the 16th. of the following month, in the quaint little Presbyterian church which still stands on St. Gabriel Street.

The father seems to have fully appreciated the value

* It has been frequently stated that Sir William Logan's grandfather was one of the Loyalists who, at the time of the American Revolution, retained their allegiance to the British Crown, and that he then removed from the neighbourhood of Schenectady, New York, to Montreal. Of this, however, we have not been able to find any good evidence. Sir William's grandfather and father were both born in Scotland, and we know that the family still resided there in 1772, and also that they were living in Montreal in 1785. Shortly after returning to Scotland in 1815, Sir William's father wrote to Mr. John Catanach, of Montreal, as follows:—"It is vain for me to attempt to describe with what emotions I first set foot on my native shores after an absence of more than thirty-one years. It would require a long winter night to tell you all the ideas that rushed upon my mind at that moment, and I must decline the task." From this it would appear that he had left his "native shores" about 1784.

of education, and sent William and his brothers to an excellent school kept by Mr. Alexander Skakel, afterwards head-master of the Royal Grammar School, on Little St. James Street. Skakel and his school are still remembered by not a few of the citizens of Montreal. He was a determined Scotchman, and, like many a schoolmaster of his day and generation, was thoroughly acquainted with the art of flogging. But he was also a



ST. GABRIEL STREET CHURCH, IN 1839.

good classical scholar, and trained his pupils well. Under him young Logan seems to have progressed satisfactorily, and to have acquired among other things a capacity for thrashing boys bigger than himself. Whether he had learned all that his Montreal master had to teach him we are not told, but, at any rate, in

1814, the father determined to send both him and his brother Hart to the High School at Edinburgh, in order that they might have opportunities for acquiring more varied knowledge.

The Edinburgh High School was then in the zenith of its reputation. There were no great public schools in Scotland answering to the English type of Eton, Harrow, or Rugby; but the Edinburgh Seminary stood forth above all the other schools of the country with a kind of natural character. Many of the most distinguished Scotsmen of the day had been educated within its walls—Sir Walter Scott, Lord Brougham, Lord Jeffrey, Dugald Stewart, Francis Horner, and others. One of its distinguishing features was the wide social range from which its pupils were drawn. Side by side on the same forms sat the sons of noblemen and of tradesmen. Future lawyers destined to rise to the highest legal offices in the country, soldiers whose names are now household words among us, clergymen who have since become leaders of thought among their fellow-men, were on terms of the closest daily intimacy and friendship with those for whom fate had reserved no more ambitious career than that of humble shopkeepers. The position of the school, in the heart of the Old Town, likewise favoured a less friendly intercourse with the boys of the poorer part of the population. In near neighbourhood lay the Cowgate and other densely inhabited thoroughfares, always ready to furnish plenty of idle lads, with whom the High School boys could wage the "Bickers," so graphically described by Sir Walter Scott in his autobiography. The training given

at the school was mainly classical, and was placed in the hands of four masters and a rector. When a boy entered he began in what was termed the first class. He was carried by the same master onward in successive years into the second, third and fourth classes, after which he passed under the care of the rector for two years. Accordingly a complete curriculum lasted six years, after which the pupils were ready for the University.

It was in the autumn of 1814 that young William and his brother Hart were taken over to Edinburgh by their uncle, Mr. Hart Logan, whose business required him to make frequent voyages across the Atlantic. On presenting themselves at the High School they were found to be sufficiently well grounded to enter the rector's class at once, without passing through the preliminary years The rector at that time was James Pillans, afterwards Professor of Latin in the University, and one of the most advanced teachers of his day. He was a man of elegant literary taste, full of enthusiasm in the cause of education, and gifted with a power of kindling some of his own fire in the breasts of his pupils. His class at the time numbered over two hundred boys, and the Logans were not long members of it before William gained the enviable position of dux. The rector soon became fond of him, and sometimes invited him to his house, an honour which was fully appreciated. Learning on one occasion that his pupil's great ambition was causing him to burn the midnight oil, he took occasion to admonish him on the folly of sacrificing health even to learning.

But the sending of two of his boys to Edinburgh was only the beginning of a more general migration which the father had been meditating for years. The old people at the farm had gone to their rest;* business had prospered, and wealth accumulated; the brother, too, having been most successful as a Montreal merchant, had transferred the headquarters of his business to London, and established a large counting-house at 44 Cross Street, Finsbury Square. What more natural, then, than that he should return to the land of his early associations, live at ease, and give his family the advantages, social and educational, which a new country could not afford! Leaving his eldest son, James, to look after his interests in Montreal, he sailed from Quebec, with his wife and remaining children, on the 14th. of August, 1815, and reaching Greenock on the 17th. of the following month, proceeded at once to Edinburgh.

Soon after his arrival there he purchased from Lord Napier a handsome residence on Queen Street (No. 71), the situation of which had greatly pleased him. "There are," he writes, "no houses on the opposite side of the street, and from it there is possibly one of the finest views in the country. The West Lothians, the Port of Leith, the Firth, with the shipping at anchor, and the coast of Fife, are in full view, and form a most beautiful and interesting panorama." French and music masters were obtained to instruct the daughters, while the two youngest sons, Edmond and Henry, joined their brothers at the High School, where they also soon took high

* Mr. James Logan died on the 15th. of January, 1806, in the 80th. year of his age; his wife on the 28th. of August, 1803, in her 72nd. year.

places. Education was, in fact, at once made the order of the day. "The boys," writes the father to a friend, in December, 1815, "are all at the High School, and I feel proud in giving you an account of their progress. Willie is frequently dux of the rector's class, in which there are upwards of two hundred boys, and at last examination he obtained two prizes. Hart is within a few places of Willie in the same class, and obtained one prize. Edmond is in the third class of 130, and only two from the top. Your little friend Henry is in the first or lowest class of 200, and has been dux for some time. The masters are highly pleased with them all."

In the following August young William wrote to his brother in Montreal as follows :—

"The examination of the High School took place on the 9th. instant, and we were all pretty successful. At the writing class Edmond was presented by the Lord Provost with a beautiful silver medal, gilt, with the following inscription engraved on it: 'Presented by Alexander Smellie, College Baillie, to Edmond Logan, for eminent proficiency in penmanship.' He came off dux in his Latin class also, after remaining in that honourable place for no less than six months, without once coming down. He received as a reward for his good scholarship 'Goldsmith's Animated Nature,' in 4 vols., with plates. Hart's prize was a book called 'Constellation,' being a collection of select passages in prose from different authors. And as to myself, for the Greek, and more particularly for the geography, at which I was second dux, I received 'Bell's Travels' from the Rector. For Latin, I was presented by the Lord

Provost with 'Bourne's Poems,' in 2 vols. The books are all most elegantly bound, and have the Edinburgh coat of arms stamped on their covers. The vacation continues till the first of October.

"To make this long reprieve from hard labour pass pleasantly, I have accepted the invitation of one of my school-fellows, Archibald Boyd, to spend a few days with him at his father's estate, near Selkirk, on the Tweed; and I intend, at the same time, to pay a visit to the son of the great poet, Walter Scott, who has an estate only a few miles distant from the former gentleman's."

Scott's estate alluded to here was, of course, Abbotsford, which, beginning in 1811 with the purchase of a farm of one hundred acres on the banks of the Tweed, was now rapidly extending its boundaries. As yet Scott was not a baronet, nor was his baronial residence erected; but he had already made important collections of historical curiosities, which he took much pleasure in showing to his guests. During Logan's stay at the home of his school-fellow, Boyd, in the autumn of 1816, the two young men paid a visit to Abbotsford, where they were received with great kindness by the poet, who not only exhibited his curiosities to their wondering gaze, but also, with his wonted hospitality, invited them to dinner.

On his return to Edinburgh, Logan became a student in the University, and during the session of 1816-17 attended the classes in logic, chemistry and mathematics. Among the professors in the University at that time were John Playfair, the friend and illustrator of Hutton,

and Robert Jamieson, who, as the exponent of Werner's views in Britain, did so much to excite an interest in geological speculation. But the teaching of these probably had nothing to do with Logan's future devotion to geology. During his one session at college he studied with great diligence, and obtained the first prize in mathematics, "with the good-will of all the competitors." His success he announced to his brother in Canada in the following letter:—

"EDINBURGH, 8*th. May*, 1817.

"MY DEAR JAMIE,—If I were to shape out an apology proportioned to the magnitude of my fault, four pages would be scarcely sufficient to contain all that ought to be said in extenuation of my negligence in not writing to you before this; but, indeed, I have not the shadow of an excuse to offer. It would not do to say that my classes and studies engaged the whole of my time. No; for had I been ever so much occupied by them, I might still have stolen a few hours on a Saturday or Sunday to write to you. It would not do to say that I had forgotten you—no, no, that would be making bad worse. It would be wronging myself; and besides, my mother has been no way remiss in desiring me to 'write to Jamie.' In fact, the best thing I can do is to say nothing more about the matter, but to show by my future regularity how sincerely penitent I am for my past delinquency.

"It is perhaps unnecessary for me to tell you that I obtained the highest prize at Mr. Nichol's first geometry class, that my name was inserted in the newspapers, &c.; for, if I mistake not, my mother, or Agnes, has told you

already, and it is not for me to speak my own praise. However, as you are a friend, and as it is probable that you will derive the information from no other source, I may venture to let you know the inscription engraved on the quadrant. It is in Latin, as you will see, and runs thus:—

GULIELMO E. LOGAN,
QUI ELEM. MATH. STUDEBAT, ANNO 1816-17,
ET SUÆ CLASSIS FACILE PRINCEPS ERAT, A PRÆCEPTORE,
GUALTERO NICHOL, A.M., EDIN.

I will not speak of the logic class, for all that I got there is a certificate; and as to the chemistry, at it prizes are never given.

"It is my intention to send to Mr. Skakel, by the first convenient opportunity, all the geometrical propositions that were done at Mr. Nichol's class during the winter, together with those given to us at the competition. The number of them is not very great, and most of them are simple, but it is to be hoped that Mr. Skakel will be pleased. Perhaps I may also send an edition of Leslie's Geometry, and an essay which I attempted at the logic class. . . .

"All hands here are busily employed in preparing for my departure for London. . . . Ten days is all the time that I have now got to spend in Edinburgh, and this I shall employ in walking about and seeing all the remarkable buildings in and near the city. For although I have been three years here, yet I have not gone through one of them, not even Holyrood House; and it would appear somewhat strange if at any time I were asked what I thought of them, to answer that it

had never entered into my head to examine them. I know not yet whether I am to go to London by sea or land; but, at any rate, when I do go, Agnes is to accompany me, and no doubt we will both of us be much surprised and delighted with the wonders and amusements of that mighty city. My regret on leaving Edinburgh will be sincere, and although I carry along with me so pleasing a companion to beguile the journey, yet my thoughts will often recur to the dear friends that I have left behind. . . .

"I remain yours, very sincerely and affectionately,

"W. E. LOGAN."

CHAPTER II.

LIFE IN LONDON.

IT appears strange that with such prospects for success, Logan's University career should have been brought to a close so early. He seems, however, to have made up his mind to enter upon commercial pursuits, and in this he was probably encouraged by his uncle, Mr. Hart Logan. The uncle, as we have seen, had taken up his residence in London, and established a large counting-house at 44 Cross Street, Finsbury Square. Fond to a degree of his nephew, he now received him into his London office, and gave him every opportunity of acquainting himself with commercial life. Nor had he cause to regret it; for the nephew soon mastered the details of the business, and released him from many responsibilities.

For about ten years the great and busy metropolis was Logan's home, and it is to this period that we must look if we would obtain a view of many of his traits of character, which in later life only came to the surface at intervals. If, like his four brothers, he never married, and if for years he lived much in the seclusion of his study, or far away from the busy haunts of men, often

with Indians as his sole companions, it was not from any want of appreciation of domestic comfort or happiness, not that to him society was devoid of charms. He was no misanthrope. But as he advanced in life, the cause of science, which he had espoused, became more and more a ruling passion, and often masked his true nature and disposition.

When he left Edinburgh in the spring of 1817 the family still resided in Queen Street, but the father, whose increasing deafness must have interfered with his enjoyment of society, soon tired of city life with no special employment, and in 1820 purchased a small estate in the country. It was beautifully situated near the Avon, about twenty miles from Edinburgh, and was known as Clarkstone. On account of the young people the town residence was kept up for a time, but it was finally sold in 1822. At school and college the three sons continued to be "an honour to all connected with them." Hart eventually studied law, and made his first speech at the Bar in 1829 Edmond became a Writer to the Signet; while Henry, having chosen commerce as "the road by which he wished to jog through life," went to London in 1825, and entered the counting-house of Messrs. A. Stewart and Westmoreland. James, the eldest son, remained in Canada, and one and another of the daughters married and left the parental roof. But ever and anon Clarkstone became the scene of joyous family reunions.

In his younger days Logan was an excellent correspondent, and not a few of his letters to other members of the family have been preserved. As we shall see, they

are full of all the warmth of family affection and of the little details of every-day life, so gratifying to those who have once daily gathered round the same fireside. But not satisfied with writing often himself, he frequently urges his brothers or sisters to do likewise, and sometimes, by way of encouragement, praises the letters which he receives: "Let me tell you, without joking," he says to one of his sisters, "you write a very good letter. You judge well what topics will please, and you express them in a lively and agreeable manner. And now that you have broken the ice that bound the spring of your correspondence, and its waters are found to be so sweet and pleasant that he who tastes once will ever thirst after more, I hope you will not pour them out with a niggard hand."

To his brother he says, on one occasion: "Do, my dear James, send us just a line now and then. You cannot think how it would gratify us, and of how much anxiety it would sometimes relieve our good father and mother" And at another time: "When I was in Scotland in August, there was a universal complaint at Clarkstone that you never wrote. I really believe that the reason of your not doing so is because you conceive it necessary to take a great deal of pains in putting your ideas on paper, and thus, making an unnecessary labour of the matter, you are unwilling to enter upon it, and defer from day to day But really you need not mind what you say, if you only say something Nobody there is disposed to criticise, and if anyone were, I am sure they would have nothing to find fault with." In this way, and by regularly causing the letters which he

himself received to circulate among other members of the family he aided in keeping alive that union and interest in family affairs which so often ceases when the children grow up and become scattered.

Portions of some of the letters written to his brother James during this period are here transcribed as serving to give a better idea of the man than could any narrative based upon them :—

"LONDON, 23*rd. August*, 1817.

"MY DEAR JAMIE,—Agnes and uncle left on the 5th. instant, and got down to Edinburgh safe and sound, and little fatigued, on the 8th. On the 11th. my father and uncle set out for Crawford Moors, but owing to the continual bad weather and incesssant rain, they have not as yet been able to fire a shot. All the rest of the family have gone to spend a few months at Kincardine House, a delightful place which my father has hired for half a year, near Auchterader, about twelve miles from Perth.

"It gives me very great pleasure to inform you that all the boys, I mean Hart, Edmond and Henry, obtained prizes at the examination of the High School, which took place on the 8th. inst. Hart was fifteenth of the Rector's class, and got as his prize Allen's Demosthenes. Edmond, of course, was dux of the fourth class, and got Melmoth's Cicero, in three vols., 8vo., most superbly and expensively bound. Upon my word I think that Edmond is a most astonishing fellow. He has been at the head of his class, consisting of 180 scholars, ever since you left England. Henry, poor fellow, was twenty-fifth of the second class, which, for a boy of

his age, is extremely good, considering that the class contains 230 scholars. For his diligence he got Hunter's Livy in one volume; as well as a fishing rod from his father. . . .

"I find myself very lonesome at present, and have been so ever since the departure of my uncle and sister. My time, however, with one thing and another, is pretty well filled up. Part of the day I read Italian and French, write versions in those languages, and generally in the evening translate Gil Blas, with Alex. Gillespie, Jnr., who, by-the-by, is the greatest companion I have here. Now and then I have a look at Homer and Cicero, and mathematics is not neglected. Indeed, I carry on a correspondence with one of my fellow-collegians, Mr. Cockayne, who resides in the north of England. He sends me propositions, which, after having solved, I return to him with the demonstrations, annexing at the same time propositions to exercise his knowledge of geometry. This, in my opinion, is a rational and useful means of keeping up an acquaintance. Sometimes the flute amuses me, and I hope you have not given up playing on that instrument. When we meet we must have some duets together. On Sunday, of course, I go to church. Uncle has taken two seats in London Wall Church, where once a week I have the pleasure of listening to one of the worst preachers that ever wagged his head in a pulpit.

"In my uncle's absence I act as his agent. When letters come to hand, I send him copies of them; when bills arrive, I carry them to be accepted; when drafts on him from H. L. & Co. make their appearance, I

and killed more than all of us put together. My uncle, agitated by a desire to show how well he could shoot, shot very ill, Edmond killed right and left, and I, poor wight! was obliged to hide my diminished head, for I wasted a great deal of powder and lead."

In the summer of 1825, his mother came to visit her married daughter near London. Her coming had long been looked forward to with delight, and the occasion of her arrival was enthusiastically described by Logan in one of his long letters to Clarkstone. The letter shows not only his fondness for his mother, but also the interest which he took in the sayings and doings of children: "It gives me great pleasure," he writes, "to announce to you the safe arrival of our good mother. . . . I found that the steamboat was expected about noon on Monday; so all was prepared to receive our mother at that time. Agnes sent the carriage from Woodford, and I went down to meet the boat, which got up to her anchorage about three o'clock. I was in a small boat on the river, and was the first person who put foot on board the steam packet; so that while my mother was looking towards the shore and straining her eyes to see if she could distinguish there anyone she knew, I surprised her by taking hold of her hand. We soon got ashore and into the carriage, and made a short journey of it to Woodford, I asking and she answering many questions, in which you were not forgotten." Then follows a description of the meeting at Woodford, and the delight of the children, particularly when they found that their grandmother had "no less than half a dozen parcels" of the good things which

grandmothers are wont to carry with them when they "go visiting." "The little ones hung to her, and called her all sorts of honeyed names—'Dear Grandmamma,' 'Sweet Grandmamma,' 'Pretty Grandmamma,' &c. So that she looked like the Goddess of Fortune, and they her votaries, upon whom she bestowed her excellent gifts. And as it happens with the big children of the world, so it happened with them—the one became envious of the goods which fortune dispensed to another: 'Your sugar-plum is bigger than mine,' and 'you have got an almond more than I have,' said Alexander to Agnes. Then replied Agnes, 'But you have got three caraway seeds, and I have not got any.' Then came clamour: 'Grandmamma, give me three caraway seeds;' 'Grandmamma, give me an almond;' 'Mamma, make Grandmamma give me one of the big ones.' 'Agnes, you're a very naughty girl;' 'Alexander, I'll send you upstairs.' Then came crying; so that it was not more than half an hour after Grandmamma's arrival before she heard how nicely they could tune their pipes."

In 1826, his uncle having given him a short leave of absence, Logan visited Paris for the first time. Passing through Normandy on his way to the great French capital, he was much struck by the numerous points of resemblance between the people of that Province and the French-Canadian peasants, or *habitants*, with whose appearance, manners and customs he had of course been familiar as a boy in Montreal. Of the Parisians he shortly after wrote to his brother James as follows:—

"They are the gayest of beings that can be conceived of—constantly in search of amusement. In the summer all the world seems to live in the open air, making use of houses merely as dormitories. The Boulevards, the Champs Élysées, the public gardens, the theatre, and all places of entertainment, are continually frequented by crowds, eager to participate in such diversions as are going on. The male part of the population dresses ill, and cuts but a sorry figure; but the females put on their clothes to perfection—much better than the ladies of this country. Fine rotundity of form, however, is so universally met with, that I cannot but imagine that part of it is occasionally derived from the cork-cutter or the milliner. Indeed, a milliner is thought nothing of who cannot artificially supply the greatest defect or remedy the greatest deformity. The ladies all affect an air *mignon*, and with the head a little on one side, a smirk on the face, and a pretty little trip in the walk, they go about all day as if they had studied an attitude before the glass in the morning, and meant to carry it to bed with them at night. But it is only when dressed for show that a French lady looks well; take her at any other time and she is a slattern. So great is the contrast between her deshabille and her toilette, that, seeing her in the one and in the other, brings to mind the change a caterpillar undergoes in becoming a butterfly."

Logan was always fond of music, and not only sang himself, but also played the flute. London, during the time of his residence there, being, as now, the great centre to which the most celebrated musicians of Europe resorted, he had ample opportunity for gratifying his

musical tastes, and was frequently to be found at the opera, at concerts, or at musical parties. At this time, also, it happened that there were numbers of Spaniards in London, who, driven from their own country, had taken refuge there. With their foreign manners, their language, and their peculiar music, he was greatly charmed, and being often thrown into their society, he soon acquired such a knowledge of Spanish as to be able to converse with them in their own tongue. In the winter of 1827 a private concert was given at the house of one of his friends, at which many of these Spaniards were present, and in one of his letters he describes it in the following amusing manner:—

"Before the concert there was a dinner party, at which it was not my lot to be present, the beckoning finger of good fortune not having invited me, perhaps because there was no room. It is, therefore, out of my power to describe that part of the ceremony, the only good thing of which that came to my knowledge, with the exception of the many good things that made their re-appearance at supper, was one that came out of the mouth of a celebrated wit of our acquaintance, better than anything that went into the mouths of all the rest; for he, upon the all-devouring General V—— complaining that he had lost his stomach and could not eat, replied that, judging from the quantity sent down his throat, he was inclined to believe that if he had lost any part of his stomach it must be the bottom. . . .

"Being a fashionable man, I did not attend until half-past ten o'clock, and when I ascended the staircase and entered the small drawing-room, a dead silence

was prevailing. Madame V—— was about to sing. There was no passing into the front room. The folding-door was completely blocked up by a crowd of Spaniards and other foreigners, all of distinction, who clustered round like bees at the mouth of a hive. There was Mr. G——, with his wide-swelling nostril; General V——, with his nose for four, and Mr. S——, with his whiskers to match; Mr. L——, with his mouth shut, and Mr. B——, with his mouth open; Mr. D——, Mr. De la T——, &c., &c.

"Not without a world of difficulty, I squeezed myself through this world of men, just so far forward as to get a peep at what was going on. The musicians were collected about the piano, the fascinating little syren in the midst, L—— seated at the instrument. All were preparing to listen—the Miss De la T——s with envy, the Miss G——s with pleasure, the M——s with apathy, and our friend L—— (seated on the sofa, the beautiful Miss M—— on one side, and the beautiful Madame de L——, magnificent in a black velvet Parisian hat and plume of white feathers, on the other), with ecstacy and delight. *Ombra adorata* was the song, and how exquisitely the little woman sang it! Mr. B—— was, as usual, overflowing with high spirits. He constituted himself master of ceremonies, and unceremoniously made enough noise for the whole party. After favouring us with one of his best songs, in the execution of which, to his wife's accompaniment on the piano, he showed himself to be in capital voice, he allowed no intermission to take place in the performances that succeeded. More than once again Spanish and Portuguese airs,

many of which I had never heard before, flowed in the richest perfection of melody from the soul of La de V——. The De la T——s sang solos, duets and trios, sometimes accompanied by the piano, sometimes by the guitar, and there was a trio to the latter instrument, which I mention in particular, because the words are the production of the fertile brain which lodges in the head of their great brother, the renowned scholar, Sr. Don Manuel de la T——. L—— dashed out a grand fantasia on the piano, and Mr. B——, a Spaniard, a professor and divine performer on the guitar, astonished and enraptured our ears by some most beautiful and peculiar music, such as I had no idea the instrument was susceptible of, and such as certainly cannot be played on any other. I did myself the honour of tripping it on the light fantastic toe with Miss Monica de la T——, who in the course of conversation told me that the Duke of Wellington had *heagle's heyes*, and that she had a few days before attended a juvenile party, where she had seen a child that was quite an *Eeb* (meaning a Hebe)."

The same General de V—— and his wife subsequently gave a concert at the residence of Sir Francis Burdett, the noble baronet placing at their disposal a suite of brilliantly-lighted rooms, and supplying refreshments for the entire company—the condition, however, being that the tickets should not be less than a guinea each. Logan, who was at the concert, tells us that altogether about a thousand tickets were disposed of, putting about £800 in the pocket of the Spaniard.

The artificial life of a city has with some the effect of diminishing appreciation of the beauties of nature, while with others it only makes that appreciation more keen. With Logan the latter was the case, and the longer he lived in London the more did he sigh for the freedom of the country. Fond as he was, too, of home and its associations, it is not to be wondered at that in the confinement of the counting-house a visit to the country home at Clarkstone was long looked forward to with pleasure. Four years have elapsed since he was last there, in 1823, and now he expects to go again. In anticipation of the happy event, and also of meeting his brothers from Edinburgh, he writes to one of his sisters: "It is to be hoped that Edmond will have it in his power to make our stay the season of his annual holiday, and then, as it will be vacation time with Hart, we shall have glorious fun, and make the welkin ring again with our songs and merriment." On this occasion he was accompanied to Clarkstone by a friend, Mr. A. L. Gower, who subsequently became his brother-in-law. His hopes of meeting his brothers were also realized, and, after a short stay at Clarkstone, the four young men left together for a tour through the Highlands. This was afterwards described in a letter to his brother James (London, May 9th., 1828,) from which we transcribe the following:—

"We set out from Clarkstone on foot one morning early, and got to Stirling about noon, well ducked by a thunder-storm which overtook us before we had paced many miles of the journey. At Stirling we paid our respects to Mrs. Irvine, and the same afternoon pro-

ceeded in a stage-coach to Callander, where we slept that night, after taking an up-hill promenade, with half a dozen Highland boys and girls as guides, to see the beautiful cascade at Bracklinn Bridge, distant about three miles from the village. Next day, after taking a peep at the Pass of Leny, we walked along the shores of Loch Vennachar and Loch Achray, to the Trosachs, winding, as we went, round the base of Ben Ledi; and, having refreshed ourselves at Stewart's Inn, which we reached about twelve o'clock, we visited all the remarkable and beautiful scenery of the neighbourhood, and then ascended to the top of Benvenue—about 3,500 feet high—whence we had a magnificent prospect of mountain and flood. Our eyes commanded the whole of the scene of Sir Walter Scott's 'Lady of the Lake.' We beheld five Lochs immediately under our feet, three of which, Vennachar, Achray, and Katrine, joined in succession by a small stream flowing from one to the other, bound the base of the mountain like so many links of a chain; and there arose up round us a thousand gigantic hills. Fatigued with our exertions, we slept that night at Stewart's Inn, which was filled with visitors, even to the very barns and stables, and, among others, the Duchess of Gordon honoured the place with her presence. The following morning we took to a boat, and were rowed by a couple of Highlanders to the upper extremity of Loch Katrine, and then crossed the country on foot to Loch Lomond, visiting on our way the dirty, smoky, mud-hut (very much resembling a pig-sty), in which the celebrated Helen McGregor was born, and where is still preserved

a tremendous long gun, once the property of Rob Roy, to whom the old Highland wife, who reigns the blear-eyed queen of the place, is related. We came upon Loch Lomond at Inversnaid, where we were in time for a passing steamboat, which conveyed us to Rowardennan, at the foot of Ben Lomond. There we waited twenty-four hours, with an intention to ascend the mountain should the weather prove favourable. But it rained all the time, and clouds upon clouds capped the summit, without even seeing which, much less touching it, we embarked again on board the steamboat, and sailed to the lower extremity of the lake, where it flows into the Leven, a stream celebrated by the pen of Smollet, who had, and whose family (some of the members of which were companions of mine at the High School) still have a small property on its banks. Here we got into a coach, and proceeded to Dumbarton, thence to Dunglas (the termination of the wall built by the Romans between the Forth and the Clyde), where we boarded one of the thousand steamboats that ply on the river, and from it we soon landed on the pier at Greenock. Mr. Lewis Gower having some friends there, we were on his account obliged to remain in that dirty, disagreeable place for two days; and I have to reproach myself with not having written to you thence. There was plenty of opportunity; for the 'Cherub,' and one or two other vessels sailed at the time. But I hate writing at all times, and I was then particularly lazy.

"Again resuming our tour, a steamboat took us to Holy Loch, our legs to Loch Eck, to the upper extremity

of which we were conveyed by an *iron* steamboat. We were again indebted to our legs for carrying us to Strachur, where we once more took to a steamer, and, sailing along the beautiful banks of Loch Fyne (famous for its herrings), landed at Inverary, a very neat and commodious village, much frequented by bathers and all those gadding people who cannot stay at home during a fine summer. The Duke of Argyll has a fine castle in the neighbourhood, which, of course, we saw. The park about it is very pretty, and is adorned with some of the most beautiful lime-trees I have seen anywhere. We supped at one of the inns, of which there are two, large and convenient; but, strange to say, notwithstanding the celebrity of the place for herrings, we were served with some so offensive to our olfactory nerves that we were obliged to send them from the table. From Inverary we took a moonlight ramble to Dalmally, about twelve miles distant, which we reached about two hours after midnight. In the course of our walk we saw two beautiful lunar rainbows. The day's journey had fatigued us most completely, and, being accommodated with comfortable quarters, we slept like so many tops. Next day, notwithstanding it was Sunday and we were in Scotland, we started like giants refreshed, and walked through the uncultivated valley of Glenorchy, along the stream which gives to the valley its name. We disembogued upon Inverouran, where we took dinner, which, by the by, consisted of tea, with oat-cakes and other things fit to choke any man of sensibility; but hunger enabled us to get them down. We had walked about sixteen miles, and there were

about twenty-five more to get over before we should get to Ballahulish, where we meant to rest for the night. Some of our feet were blistered, and all our legs were tired, and it was unanimously resolved that we should drive the rest of the way, provided we could get a cart—the only carriage, fit for a gentleman, to be found in that part of the world. The inn-keeper had a cart, which had been used to carry manure the day before, and, therefore, possessed a most savoury smell, as you may suppose. This we applied for. But mine host, a fellow with a huge purple nose and scarlet face, studded with carbuncles, who was, I dare say, scarcely ever sober, whether Sunday or Monday, forsooth could not let us have the fragrant vehicle, because it was the 'Lord's Day.' But we saw through his drift, which was no other than to get a little more of our money, by causing us to sleep at his inn; and, meeting his ruse by one in return, we informed him we should walk on. Then, fearing to lose the opportunity of letting his cart, he said we might have it, although it went much 'agin his conscience.' The bottom of the cart was forthwith covered with heather, the horse 'put to,' and, packed in like four logs, we set out. After passing along on a most beautiful military road, through some of the most desolate and solitary country that, I daresay, is to be found on the face of the globe, where not a mud hut, or a creature, or a tree, is to be seen for miles and miles, we reached King's House, and while the horse was baiting, ascended a hill called the Devil's Staircase. We again got into the cart, and entered the Valley of

Glencoe, famous as the birthplace of Ossian, and noted for the horrible massacre perpetrated on the unsuspecting inhabitants by the Government troops in 1691, in the reign of William and Mary. The valley is wildly romantic. It is very narrow, and in the bottom of it runs the small stream of Cona, from which the mountains rise upon each side, rugged, broken, and precipitous, to the very great height of 3,000 feet. They overhang the road, and stand out in some of the most striking and terrific attitudes; sometimes approaching so near to each other from the opposite sides as to shut out the light of heaven. They threaten to fall upon the passenger, and bury him in a tremendous ruin; and it is not without a feeling of secret dread that one beholds this awful scenery, which in its character is not equalled by anything in the British Isles. We reached Ballahulish about midnight, after a fine moonlight drive along the shore of Loch Leven. But it was too obscure to see the slate-quarry, for which the place is famous. The subsequent day we walked to Fort William, about fourteen miles, and then ascended to the summit of Ben Nevis, seven miles more, where we found ourselves on the highest land in Britain, being 4,500* feet above the level of the sea. We had a most extensive prospect from this position. We could see the Isle of Skye, the Isles of Mull and of Rum, about sixty miles off, and the Atlantic beyond them; on the other side, the Grampian Hills. The commencement of the Caledonian Canal was almost under our feet. Never did I endure such dreadful fatigue as I experi-

* 4,406, according to the Trigonometrical Survey.

enced in ascending and descending this great mountain, the summit of which is a barren, naked rock, without a single particle of earth on it, but here and there covered with snow all the year round. . . . About 3,000 feet above the level of the sea there is a spring of very fine water, which I made a point of tasting, as it is the highest water in the island.

"Completely knocked up with our exertions, we slept that night at Fort William. Next morning we took the steamboat, and coasting along Argyleshire, and passing through the Crinan Canal into Loch Fyne again, we threaded the Kyles of Bute, and returned to Greenock the following morning, in company with about 300 Highlanders, male and female, who at 3s. a head had made this descent on the Lowlands for the purpose of getting employment as reapers during the harvest. Leaving Greenock, we soon got to Glasgow, and there taking coach, again showed our faces, somewhat sunburnt, at Clarkstone, just at dinner-time, after an absence of ten days, during which we had walked one hundred and twenty miles, coached fifty miles, carted twenty-five, boated twelve, and steamboated three hundred and fifty; climbed one hill of 3,600 feet in height, and another of 4,500 feet."

After his return to London, he wrote the following letter to Clarkstone, giving further details of his tour in Scotland:—

"LONDON, *2nd. September*, 1827.

"MY DEAR MARY,—Ever since my return to this great bustling and noisy place, what with making up the lee-way my absence has occasioned in the counting-

house, what with the hurry-skurry produced by my uncle's departure from town in time to get to Kentwell to shoot on the first, and my aunt and Mrs. Parker's preparations for their final removal to the country, I have not had a moment's leisure to put pen to paper on any other subject than business. Just at the instant of Dr. Dickson's departure for Scotland I was particularly engrossed, and could not write by him to give you an account of my journey hither, and a few of the various adventures that befell Lewis and myself on the road. By the boy that drove us to Lanark, I returned a note to Edmond, to let him know that we had got that far. I told him that we had seen the Falls of the Clyde, which are very beautiful, and that we intended to proceed southward the next day. But next day we did not proceed; and it was altogether the fault of Lewis, who broke through an agreement we had made to prevent delay either at Lanark, where I had friends, or at Newton Stewart, where he had friends. I knew that if I called on the Gillespies at Sunnyside, I should be pressed to stay another day; and he knew that at the Manse of Kirkowan he would be pressed to stay a week instead of a day, the time we had set down as all we could spend there. So we agreed that among my friends he should pretend a great hurry to be up to town, and that among his friends the hurry should be mine. . . . Having satisfactorily arranged this plan while we were at dinner at the Clydesdale Inn, towards evening we went with Mr. Menzies to pay our respects to Mrs. Gillespie, at her beautiful villa on the banks of the Clyde. But on our way thither we visited that romantic

glen, the Cartland Crags, through which the River Mouse runs, between lofty, rugged and precipitous, but thickly wooded sides, to join the Clyde, passing, as it flows along, under a new bridge, built of freestone, and consisting of three arches, of which the middle one is 150 feet high.* It was rather late when we reached the glen, and in the obscurity of the evening we had but an imperfect view. But it appeared to my companion so romantic a place that, wishing to observe it by a more perfect light, he silently determined to break through our settled plan of proceeding on our journey in the morning. This I found out when, after spending the evening very agreeably at Sunnyside, and being on the point of returning to our inn, Mr. Gillespie, as had been anticipated, most urgently pressed me to remain next day in the neighbourhood, where there was a great deal worth seeing, and to dine with him in the evening. Agreeably to arrangement, I said that nothing would give me greater pleasure, were not my friend, Mr. Gower, pressed for time to such a degree that it would be out of our power. Mr. Gillespie then turned the battery of his eloquence to Lewis, who, at once, and to my utter astonishment, said that he could and would with pleasure spend all next day in visiting the beautiful scenery about Lanark, and dine at Sunnyside in the afternoon. Our concerted plan thus frustrated, I could, of course, be nothing less than very happy to do the same.

"Next morning we got up very early, breakfasted at

* Black says:—"About thirty years ago a bridge was thrown across this ravine, consisting of three arches, 128 feet in height."—1861, p. 391.

the Manse, where tea was made for us by the fair hand of Miss Menzies, and thence proceeded in Mr. Gillespie's gig, first five miles along the banks of the Clyde, above Lanark, and then ten miles by the same beautiful stream, below Lanark, visiting all that was worthy of a stranger's attention, not omitting Tillytoodlem Castle, and taking another peep at the Cartland Crags. We dined with Mr. Gillespie in the afternoon, and met Mr. Patterson and Mr. Greenshields at his table. Next morning we proceeded in a hired gig round the base of Tinto to Chester Hall Inn, a distance of about ten miles. There we met an Edinburgh coach, which took us by the stupendous vale of Dalven, and the wooded vale of Nith (where we had a glimpse of Douglas Castle, the seat of the Duke of Buccleugh), to Dumfries. . . Believe me very affectionately yours,

"W. E. Logan."

Logan's uncle seems to have given up his London residence in 1827, and gone to reside all the year round at his country-seat in Suffolk, leaving to his nephew the responsibility of managing the business in the metropolis. The change, on the whole, appears to have been pleasing to the latter, who was beginning to tire of the many parties and dinners to which he was subjected while living with his uncle on Wimpole Street.

"I shall not," he says, "much lament the change, for then I shall get lodgings in the city, and thus be nearer to the scene of business, and save the time I now daily lose in walking to and from the counting-house—two hours, at least. Besides, I shall be able to

lead a more quiet life. . . . Much company, rich food, and rich wines, are things disgusting to my taste and prejudicial to my health. Henry and I will lodge together, and those evenings that are not taken up with business we shall occupy, sometimes with a little music, sometimes with a little drawing, and very often with much reading."

Writing to Montreal in the spring of 1830, he says:—"I do not think I have ever informed you that Henry and I have taken up our quarters in Finsbury Square, number 47. We reside with a young gentleman who is an old school-fellow of Henry's, and who, having spent many a day at Clarkstone, is well acquainted with all of us. Robert Dickson is his name, and Doctor is his title."

To what extent, during his life in London, Logan devoted himself to pursuits or amusements of a scientific nature, we do not know; but the study of geology was apparently not begun until after he went to live in Wales. Shortly after his arrival there, in the spring of 1831, he wrote to his brother Henry, asking him to send him some of his "goods and chattels," which had been left in London. "In the first place, put into my trunk as many of my old clothes as I have left behind. This will be a famous place to wear them out, and, indeed, at the works it would be a sin and shame to wear anything else than old clothes. In the next place, put into it as many of my *scientific* books as you can, particularly such as are connected with mechanics and chemistry; and I will thank you to purchase and add to such as you find, the 3rd edition of Turner's

Chemistry, and some good work on mineralogy and geology. Dr. Dickson will be able to tell you which are the best. In the third place, stuff into it my pencils, drawing-boards and drawing-paper, and my case of instruments; and if it will hold any more, put in some of my flute-music." In a letter written to his brother James two years after this (June, 1833,) he says: "The study of the ores of copper has gradually led me to that of mineralogy and geology, and of specimens in both departments I have become a bit of a collector. Now, if you could assist me to a few of Canadian origin, I should be obliged. Any steamer coming to Swansea or Neath would bring them almost to the door. . . . At first you need not be very particular in your choice; even a collection of the pebbles of various kinds to be found in the river would be welcome, and so would small fragments broken off from any of the strata near or far from you, such as from the mountain, from Cape Diamond, Quebec, &c., &c. Specimens having the appearance of shells, or organic remains of any kind, would be preferred. Let me know where they come from as exactly as possible, and you can say, also, what you consider them to be. By the way, I am informed by our good cousin, William Edmond, who, you are, I take it for granted, aware, is here with me, that his brother James has provided him with a collection of whatever he meets with that is curious. If, therefore, he has been practising, he will assist you.

"Did you ever hear of any copper ore in Canada, or anywhere near it? If any were discovered it might

become a matter of profit to us, if we could get hold of it, and it proved of good quality. Recollect this, and keep the matter before you. I understand there has recently been a mine of it discovered in the State of Connecticut, and I am told, also, that there is copper in Nova Scotia. It would be no matter of surprise if some were found in Canada within reach of the St. Lawrence."

CHAPTER IV.

COPPER-SMELTING AND COAL-MINING.

ABOUT the year 1828, a process having been discovered in Wales for extracting copper from the slags which had previously been abandoned as useless, the inventor communicated the secret, for a consideration, to certain gentlemen, who soon bought up, at very little cost, millions of tons of slag, and began smelting operations in the neighbourhood of Swansea.* In securing the necessary capital for their enterprise they were greatly assisted by Logan's uncle, to whom, in return for his services, they afterwards gave an eighth share in the business, on the condition, however, that he should contribute £10,000 in money. In the terms of co-partnership, the uncle, who was desirous that his

* From information kindly supplied by Dr. Percy, of London, it appears that the process mentioned here, for the extraction of copper from ore-furnace slag, did not prove a success. Dr. Percy says: "I have visited the works where the process was to be conducted (near Neath), and remember seeing some of the very slag accumulated there. But certainly the process came to nothing." The smelting operations superintended by Logan were, therefore, probably carried on in accordance with the ordinary Welsh process.

nephew should represent his interests in the business, reserved the right of giving him part of his own share. But the young man preferred accepting a salary. "Having," he says, "nothing to lose, I am unwilling to become responsible as a partner, and have stated to our uncle that I will not accept a share until I have become acquainted with the business, and am able to satisfy myself from experience and personal observation that it is of the profitable nature his friends represent and he thinks. In the meantime I shall require a salary, which, he said, should be £1,000; but, for my part, I shall be content with less. When I was in Scotland in August (1830), I spoke to our father on the subject, and he thinks with me, that a salary would, at first, be preferable to a share. If, when the business is ultimately proved to be so profitable, those concerned will not give me a share, why I cannot help it; but I hope to make myself so useful that they will not refuse." In this we have a glimpse of the characteristic caution which afterwards proved so valuable to him in his professional career. Though less sanguine than his uncle with regard to the enterprise, he was nevertheless pleased with the prospect of a new line of life in Wales. "It has," he writes, "been arranged that I shall go down to Wales, where it is intended that the chief part of my duty will be to attend to the accounts of the establishment; but you may be assured I shall spare no pains to make myself master of every branch of the business, and as it is of a scientific nature, I am pretty sure I shall like it." The difficulty, however, was to get some one to assume the management of affairs

in London. At first it was planned that his brother James should leave the Canada branch of the business, and go to London; but this was afterwards found inexpedient. Other arrangements having finally been made, Logan left for his Welsh home in the spring of 1831, and began his labours at the Forest Copper Works, Morriston, near Swansea. For a time he was chiefly engaged in the counting-house, where, he tells us, he toiled from six or seven o'clock in the morning until midnight, in order to establish a proper and regular system of accounts. But eventually he had to attend both to the smelting of copper and mining of coal.* "Here I am," he writes to his brother, in June, 1833, "out of the world altogether, and attending to nothing else but the making of copper and digging of coal from morning till night." From the digging of coal, however, he was led not only to thoroughly investigate the question of its origin, but also to study the structure of the Glamorganshire coal-field, in which his uncle's mines were situated. A theodolite, compass, and other instruments, were purchased at his own expense, and all the spare time which he could command enthusiastically devoted to the production of a geological map of the district.† His measurements, as they were obtained, were laid down upon the one-inch sheets of the Ordnance Survey, and with a minuteness of detail

* Owing to his close application to office-work, his eyesight was for a time seriously affected.

† Writing in 1832, to his brother in London, about the purchase of a theodolite, he jokingly says: "If a pound or two more would make the theodolite much better, I should be disposed to give it. I'll live on milk diet, and save the money in a short time. But do not let ornament have anything to do with the additional expense."

which had probably not been observed before in any of the geological maps of the country. When Sir Henry de la Beche began his geological survey of that region, he must have been not a little surprised at the extent and thoroughness of Logan's work, and when the modest amateur generously handed over to him his maps, De la Beche not only accepted them, but adopted them for the Government Survey, on the early sheets of which Logan's name is engraved, together with those of De la Beche, Ramsay, Phillips, and Aveline. In the capacity of a volunteer on the staff of the Survey in South Wales, Logan also proved of great assistance, and, among other services, introduced horizontal sections on a true scale of six inches to a mile, which served as models for the large sections of the Survey.

In the spring of 1833 he was obliged to go to London to attend to some of the affairs of the "Copper Company," and was greatly annoyed at being detained there awaiting certain legal decisions. "Here I am," he writes to his brother Hart, "tied by the leg until the lawyers have brought to a conclusion the arrangement that is on foot to push Mr. —— out of the Forest Copper Company; and when I think of the work that is accumulating for me at Swansea against my return, I feel as sick of London as possibly can be. If it were not for the consolation of a little geology, a leap from London Bridge would be my only care."

By way of obtaining the desired consolation, he went to the Island of Sheppey on a geological excursion, the incidents of which afforded him much amusement. Possessed of that rare faculty of adapting himself to his

surroundings, and of heartily entering into whatever most interested those into whose company he happened to be thrown, he everywhere made friends, and at the same time acquired—often from the most unlettered—a great deal of valuable information. Gifted, too, with a keen sense of humour, and supplied with a never-failing fund of anecdotes suitable for various occasions, he was equally welcome in the drawing-room, the country inn, the farm-house, or the stage-coach. Some of these characteristics appear in the following account of his excursion to Sheppey, taken from a letter to his brother Hart :—

"I had a very satisfactory excursion on Saturday and Sunday last down to the Island of Sheppey, to examine the London Clay formation. Starting at two o'clock on the first-mentioned day, I got to Chatham about six, and put up at the inn where the coach stopped—not the very best in the world, but good enough for the occasion. I was put into the only sitting-room in the house, had my tea, bespoke a bed, and intended to take mine ease in mine inn till bed-time, sitting at the fire, with 'Phillips and Conybeare' in my hand. But about eight o'clock my studies were broken in upon by a smoking club, which had met in that room every Saturday night for the last forty years. The members were ushered in with all the insignia of their solemn duties: pipes, tobacco, spitting-boxes, and each a glass of brandy and water—some hot, some cold *with*, and some cold *without*. There was the Mayor of Rochester among them, the parish clerk, a political tradesman or two, a few ship breakers-up, and mine host himself. I called for a glass of negus, and joining in the conversa-

tion, which was sometimes political, and sometimes trade-ical, I was a good deal entertained. One of the political tradesmen read us occasional extracts from a newspaper, always making *v*'s *w*'s and *w*'s *v*'s, putting in *h*'s where there were none, and leaving them out where they ought to be; and these said readings universally led to discussion. The reader, as you may imagine from his style, showed himself a Whig and a Radical; but we had our Tories and Conservatives too, and they were represented by the Mayor, who seemed the only one approaching to a gentleman among the whole set. After filling the house with the vapours of their arguments, pipes and brandy, these my friends paid their scores and turned out about eleven o'clock; so I went to bed. But I was up again at three in the morning, to start for Sheerness by a forty-ton vessel, half boat, half smack, which goes every tide. In the cabin, where it was impossible to stand upright, I found myself among another queer set, sailors and their wives, &c., drunk and sober, some going on board merchantmen, some of men-of-war, and all as noisy as the devil. I selected for my especial companion an elderly Irishman, who happened to be a tailor in Rochester, and was on a voyage to pay a visit to a son, bandmaster on board the 'Donegal 74', just arrived at Sheerness. I was much entertained with the man's stories, for he had been a regimental tailor in the 39th Infantry, and had seen a good deal of service in the Peninsula and in Canada.

"I got to Sheerness and to breakfast about seven o'clock, and then started forth geologizing along the northern coast of the island, and having the good

fortune in the course of my walk to meet with another Irishman, and to fall into conversation with him, I found he was what was called the curiosity-man in Sheerness, from his occasionally walking forth in search of such things as I was looking for, when he was out of work. I could not have got into better hands, for he showed me all that was curious, and where to get the best fossils. I got several fossil crabs, lobsters, shells, wood, seed-vessels, &c., &c. The coast is very well described in 'Phillips and Conybeare,' and I saw places where there had been slips of huge masses of the soft cliff that stretches for miles along the shore, and in one spot there appeared about four acres of a wheat-field, which was cracked in various directions, and only awaited very wet weather to be precipitated into the sea."

In 1834 Logan went on a journey to France and Spain, and was absent for several months. The journey was probably undertaken in the interests of the Forest Copper Company, as he visited a number of the Spanish copper mines, and made notes with regard to the cost of mining, price of ores, &c. The knowledge of the Spanish language which he had acquired while in London, now stood him in good stead, as did also the many letters of introduction which he carried with him from some of his old Spanish friends. In those days travelling was a slow process. From London to Dover by coach occupied ten hours; from Calais to Paris, by diligence, from noon one day until eight p.m. on the next. From Paris to Bordeaux, again, was a journey of two days and three nights. Logan spent several days

in Paris, and while there saw the funeral of Lafayette, which, he says, was "not very imposing." He had his sketch-book with him, and took views of Calais, Bordeaux, and many other places in both France and Spain. He also made notes on the geology of the country through which he passed. Notwithstanding the danger of travelling through the mining regions of Spain at that time, owing to the numerous robbers who constantly prowled about in search of the unwary, he seems to have escaped molestation.

During his residence in Wales, Logan's fondness for geology daily increased, and it was not long before his work began to attract the attention of some of the leading British geologists of the day. In 1837 he was elected a Fellow of the Geological Society, and the same year was present at the meeting of the British Association, at Liverpool, where he exhibited his map of the South Wales coal-district. It was greatly admired, as no such work had previously been executed, unless by the Ordnance Survey. Early in the same year he wrote to his brother in Montreal as follows: "If I mistake not, I have more than once asked you to send me a collection of Canadian minerals, which, however, have never made their appearance. I am anxious to have them, because we have set up a museum here, of which I have the honour to be Secretary. You have a museum in Montreal, have you not? Now, if exchanges could be effected, it would be a capital thing. We have here all the ores of copper and iron in great abundance, and are located in the midst of a coal-basin, which abounds in vegetable remains. I am

anxious to know what you have in your neighbourhood. You must know that I have become a bit of a geologist of late years, and am now entitled to write after my name F. G. S.—being a Fellow of the Geological Society. I take a great interest in the science, and some day or other I may appear in print. The locality to which I have especially directed my attention is this immediate neighbourhood, of which, during leisure hours, I am gradually getting up a geological survey and sections. If ever I return to Canada again I shall geologize there." This was only six years before he became Director of the Canada Survey. The museum to which he alludes in his letter was that of the Royal Institution of South Wales, for the interests of which he was an active worker during his stay near Swansea. Not only was he Honorary Secretary, but Curator of the Geological Department, and the Institution is indebted to him for valuable collections of minerals and metallurgical products, books, drawings, laboratory apparatus, and a fine collection of the indigenous and migratory birds of Canada. The birds he himself both shot and stuffed when on a visit to Canada, and among them several previously unknown or undescribed species were discovered. Subsequently, it is stated, Mr. Logan was appealed to by Audubon, the ornithologist, for aid in the accomplishment of his great work upon the birds of North America.*

In 1838, his uncle, who had ever taken a lively

* The above statements with regard to Logan's ornithological proclivities are given on the authority of Alexander Murray, Esq., C. M. G., of St. John's, Newfoundland.

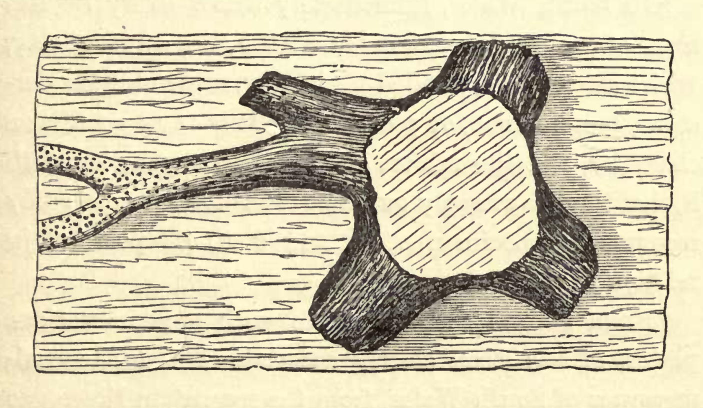
interest in his welfare, died, and not long after Logan resigned his position in Wales—a position in which he had enjoyed the best of opportunities for the development of his eminent talents as a stratigraphical geologist. Then, as afterwards, he had a keenly observant eye for all the phenomena presented to him in the progress of his researches, and the question of the origin of coal happening to engage his attention, he devoted himself to it with great enthusiasm. His work in connection with this subject will be considered in the next chapter.

CHAPTER V.

STIGMARIA.

At the time of which we write, the questions relating to the origin of coal were in a somewhat unsettled state. It was generally admitted that coal is of vegetable origin, and many species of Carboniferous plants from the shales and sandstones accompanying the coal-beds had been described and figured. But the precise circumstances under which the coal accumulation had taken place still remained an open question. On the one hand, the coal-seams had been likened to the accumulations of drift-wood, which take place in certain lakes and at the mouths of great rivers draining wooded countries. On the other, they had been supposed to have grown in the manner of peaty swamps. These theories of growth and driftage were warmly agitated, and objections of various kinds arising from the supposed climate of the Coal-period, the character of its vegetation, the difficulty of accounting for the regularity, purity, and uniformly-bedded conditions of the coal-seams, could be urged against both theories.

In these circumstances, Logan had the sagacity to observe and turn to account a fact which has settled forever the question of the origin of coal in favour of the theory of growth *in situ*. Under eighty or more coal-seams which occur in the Welsh coal-field, the miners had observed the invariable presence of a bed of more or less tenacious and bleached clay, which they called the "underclay" of the coal, and which was often of practical importance as affording facilities for undercutting the coal. The constancy of this fact Logan confirmed by his own observations, and added to it the further and important discovery that in all these



STIGMARIA ROOTS OF ERECT SIGILLARIA, SEEN FROM ABOVE AFTER REMOVAL OF THE TRUNK (PORT HOOD, NOVA SCOTIA.)—*Dawson*, "*Acadian Geology*."

underclays there occurred abundance of remains of the peculiar plant known as *Stigmaria*, in such circumstances as to show that the plant was *in situ*, and not drifted. The conclusion to be deduced from this was obvious. The constant occurrence of an underclay containing a particular plant was altogether adverse to

the theory of drift, while it gave the strongest support to that of growth, with the additional indication that the plant which had been mainly instrumental in promoting the growth of coal was that known as *Stigmaria.*

Mr. Logan laid the results of his researches in this matter before the Geological Society of London, in February, 1840, in a paper entitled, "On the Characters of the Beds of Clay immediately below the Coal-Seams of South Wales." As this paper is interesting in itself, and affords a good example of Logan's style at this early period of his career, a considerable portion of it is reproduced here:—

"In South Wales, immediately below every regular seam of coal, and co-extensive with it, lies a bed of clay, which is commonly called underclay, undershift, understone, bottomstone, or pouncing. It is of so peculiar a character, and the miners are so well acquainted with it, that there is scarcely one who would not immediately recognize a specimen of it, and state its position in relation to the coal.

"From several sections made with care in various places, it has been clearly ascertained that the coal-measures of South Wales, from the mountain limestone upwards, attain in the deepest part the great geological thickness of 12,000 to 13,000 feet. They contain nearly 100 thick and thin seams of coal, about one-half of which, measuring a foot and upwards in thickness, have in various places been more or less worked, and I am not aware of a single instance of a seam unaccompanied in any part by this subjacent bed; indeed, so thoroughly is the Welsh miner persuaded that the two

things are essentially conjoined, that he would as soon expect to live in a house without a foundation as to work in a coal-seam which did not rest upon underclay. It is very necessary that he should be familiar with the material, as it occasionally serves a most important purpose in prosecuting the work of a coal-mine; for, though there is never coal without a subjacent bed of underclay, there is sometimes underclay without superincumbent coal. A seam of coal which becomes thinner by degrees will occasionally vanish altogether; but, after a short distance, it will appear in increased thickness, and ultimately regain its original dimensions. When a collier, meeting with an irregularity of this description, perceives the coal disappear, he might find it difficult to know whether he had not suddenly come upon a fault completely dislocating the measures if he had not the underclay to guide his course; and it is only when this fails that he feels assured the direction of his search must be changed.

"This underclay, as its name imports, is generally more or less argillaceous, but is never without a considerable admixture of sand; and it is always of a fine texture, yielding, in most cases, a very good fire-clay. In many parts of the coal-deposit of South Wales it is tough, though not very hard, when fresh cut; but on exposure to the weather it slacks, splits, and crumbles into a greyish mass. It is occasionally quite black from an admixture of carbonaceous matter, and is then sometimes sufficiently consistent to resist the effects of weather; and under some of the lowest seams of coal between Swansea and the Bury River, it yields a hard,

durable, fine-grained, siliceous stone, very much resembling quartz rock.

"It is not, however, by the mineralogical composition that these beds are so thoroughly marked, for they not only vary considerably, but many strata occurring in other parts of the coal-measures, are precisely identical in mineral contents. The grand distinguishing feature of the underclays is the peculiar character of the vegetable organic remains: these are always of one kind (*Stigmaria Ficoides*), and are so diffused throughout every part of the bed, that by their uniform effect alone the clay is readily recognized by the eye of the miner.

"The beds, varying in thickness from six inches to more than ten feet, and averaging about three, are crossed and penetrated vertically, horizontally and obliquely, by a confused and tangled collection of long, slender, fibrous casts, with a thin coating of carbonaceous matter. These fibres are sometimes cylindrical, though generally flat, and are usually about a quarter of an inch in breadth; but they are very often traceable to a junction with a stem or branch, sometimes flattened, sometimes not, and varying in diameter from about two inches to half a foot. From this stem or branch, which is usually of considerable length, and always lies in the plane of the bed, but rather nearer the top than the bottom, the fibres radiate in all directions, and take such a tortuous, irregular course that it is impossible to follow any one of them to the natural termination, though it is easy to see that the range is very considerable. This fossil, the *Stigmaria Ficoides*, taking for granted that the slender, fibrous impressions belong

always to it, so completely fills every bed of underclay, that it is not possible to cut out a cubic foot which does not contain portions of the plant. It is always worthy of remark that specimens with the fibres emanating from the stem or branch, are to be discovered only in the underclay

"It is proper, however, to state that such specimens, even if they did exist in other beds, are not so likely to become exposed in them; whereas the operations of extensive colleries naturally afford the opportunity of making vast collections from the underclays; for when a coal-seam is either throughout or partially too thin to permit the excavation of the coal without the removal of some portion of the ground in juxtaposition to it, the superior softness of the floor induces the miner to make the required cuttings in it, rather than in the ceiling; or when it becomes necessary to obviate the effects of a 'creep' in any of the roads, it is again the floor that is pared down, and in these and other ways a large amount of specimens in the underclays is exposed. Sometimes, however, the ceiling of one coal-seam is the floor of another, and in such instances, if the collector were on the lower bed, he might discover above him specimens that would appear to contradict what is above stated to be a general rule, while it is obvious an attentive examination of the case would only confirm the truth of it. That bare stems or branches of *Stigmaria* have been found in other beds there can be no doubt—indeed, it would be very surprising if many such instances did not occur; for even if the underclay were the natural and original site of the plant, speci-

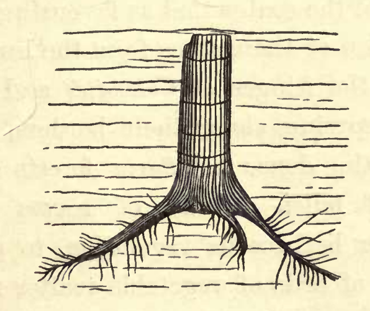
mens must have been occasionally washed out of their first position, and deposited in some superior bed at the time of forming. . . .

"When it is considered that, in so wide a district of country abounding in coal, there is not a seam which is not immediately underlaid by a bed wholly monopolized by these peculiar vegetable organic remains, it is impossible to avoid the inference that some essential and necessary connection exists between the production of the one and the existence of the other. To account for the unfailing combination by drift, seems an unsatisfactory hypothesis; but whatever may be the mutual dependence of the phenomena, they give us reasonable grounds to suppose that in the *Stigmaria Ficoides* we have the plant to which the earth is mainly indebted for those vast stores of fossil fuel which are now so indispensable to the comfort and prosperity of its inhabitants."*

At the time when Logan's paper on underclays was written, the plant known as *Stigmaria* was little understood as to its precise nature and affinities. Its branches, which are among the most abundant fossils of the coal-measures, present round depressed spots, or areoles, arranged in spiral order, and when the interior structure is preserved, they show a central axis of fibrous texture (scalariform fibres), surrounded by a thick cellular bark, and this enclosed in a dense rind or outer bark. The organs attached to the areoles of the surface are very long, cylindrical, soft bodies, about a quarter of an inch in thickness, whether roots or leaves. radiating in all

* Transactions of the Geological Society of London, VI., p. 491.

directions, an attached to the branch by a distinct articulation, leaving a clean scar where they have been removed. When complete specimens were found they presented a central cylindrical or dome-shaped mass, from which the branches were given off by a regular bifurcation. At first the regularity of these bodies and the definite arrangement and true articulation of the organs attached to them seemed to negative the idea of their being roots, while the fibrous structures and tendency to exogenous growth in the branches prevented them from being regarded as aquatic plants of low organization. The tendency among botanists was thus to regard *Stigmaria* as an aquatic plant of high organization, which had established itself in ponds or lagoons, filling these up with its growth, so as ultimately to form a vegetable deposit which might support other kinds of vegetation. Later observations, however, both in Europe and America,* have shown that *Stigmaria*



SIGILLARIA, WITH STIGMARIA ROOTS (SYDNEY), AFTER R. BROWN.
From "Acadian Geology."

was functionally a root, and that it supported the trunks of trees known as *Sigillariæ* and *Lepidodendra*,

* By Binney, Brown and Dawson.

and their allies, which are the most common trees of the coal period, and out of whose debris the greater part of the coal was formed. Under the microscope the coal itself has revealed the structures of *Sigillariæ* and other trees having *Stigmaria* roots*, while the leaves and other aerial parts of such trees have been found in abundance in the shales forming the roofs of the coal-beds. Numbers of erect trees occur with their roots fixed in the coal-beds, and other beds of sandstone or shale have been found to contain erect trees of the *Sigillaria* type, with their roots fixed in *Stigmaria* underclays, which thus not only support coal-beds, but sometimes fossil forests, which did not exist sufficiently long, or in sufficiently favourable circumstances to produce beds of coal.

Thus the theory of the growth of coal *in situ* is now firmly established, and in connection with this we are in a position to assign due importance to the extensive swampy flats of the coal-period as favouring its deposit; to the protection of these areas from the inroad of sand and mud by the fringes of *Calamites* and other reed-like plants growing along their borders, and to the character of the dense *Sigillaria* forests as affording abundance of fallen trunks, of leaves and fruits, and of smaller herbaceous vegetation, to promote the accumulation of beds of vegetable matter more extensive and important than those of any other geological period.

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* Goeppert has observed these facts in Germany, and Dr. Dawson has described the structures found in about eighty distinct coal-beds of the coal-field of Nova Scotia in the Journal of the Geological Society, and in his "Acadian Geology."

Some points still remain open to discussion. According to Dr. Dawson, an undue importance has been attached by certain observers to the spore-cases found in certain layers of coal, whereas cortical or bark tissues in general, including those of spores or spore-cases, should be credited with the greater part of the material of coal. The exact botanical affinities of the *Sigillariæ* are still in some doubt, and though these trees have borne the principal part in coal accumulation, there is also much to be attributed to *Calamites*, *Lepidodendra*, ferns and other plants of the period.

All these subjects have been fully discussed by Dr. Dawson in his various papers, and in his "Acadian Geology," to which the reader is referred.

CHAPTER VI

CANADA REVISITED.

THOUGH for so many years resident in Great Britain, Logan never lost his interest in his native country. While in London he was Vice-President of the Canada Club, and he always kept himself informed with regard to the political movements and commerce of the colony. Now that geology had become his favourite pursuit, he longed to scan with critical eye the rocks over which he had climbed as a boy; and accordingly, being free from business engagements, he set sail from Liverpool in August, 1840. Among his fellow-passengers on the steamship "Acadia" were Sir George Seymour, Sir Joseph Copley, Lt.-Colonel Balfour of the Guards, and several other military men; also, the late Mr. John Greenshields, of Montreal.

The daily incidents of the voyage were duly chronicled by Logan in his journal; but as nothing of special interest occurred, we extract only what is said of the 15th. of August, the day on which the vessel arrived at Halifax:—

"Up at six. I got a sight of the land. The place is supposed to be Garsons Point [?]. But now, after breakfast, the weather has got as thick as mustard, and we cannot see 100 yards from the ship. We are firing guns and ringing our bell, the first to attract a pilot, if there is one within hearing, and the other to keep off a vessel which we approached rather closely a few minutes ago.

"At 10 a.m. we supposed ourselves to be off Halifax Harbour, and kept firing occasional guns until dinner time, the fog continuing very thick, and damping the spirits of us all, as well as our clothes. When the clergyman commenced asking a blessing at dinner, a shot was fired on deck from a twelve-pounder, which rather disconcerted him. He, however, did not forget to pray, among other things, for the removal of the impediment offered to the termination of our voyage; and no sooner had he uttered the request than our shot was replied to by two from the shore. When the clergyman sat down he instanced the fact as exhibiting the influence of prayer.

"Before we had finished dinner another shot from us was replied to, and shortly afterwards we heard the sound of a pilot's horn. The boatswain then got a musket, and fired away in reply to the horn, and the horn sounded in replication to the musket, gradually approaching all the while, until at length a couple of small sails emerged from the mist and showed us the boat, dimly visible at first, but at length sufficiently distinct to exhibit two men. The boat soon got alongside, and the pilot sprang on deck. I never saw such

a regular built Dutch figure that did not speak the language of Holland. The first thing he did was to tell us our head was pointing the right way, and that all we had to do was to paddle on. In five minutes we got out of the fog, which we found to be, after all, but a partial one, extending across the mouth of the harbour like a wall; and when we had done so we found ourselves close to Sambro Lighthouse, not more than two miles from the land, and about fifteen from Halifax.

"All our steam was put on, and we shot up the harbour like a dart, passing rocks of granite on each side, and fortification after fortification. At length, approaching the lower end of the town, we were saluted by cheers from assembled thousands, and from every wharf in succession, until we swung round to the wharf of our destination, alongside of which we were soon placed, after smashing our figure-head against a wooden building, which was very nearly carried away by the shock.

"I suppose it was about half-past seven or eight o'clock when we became stationary, but I forgot to look at my watch for the purpose of ascertaining. Then came a great bustle, as we heard the vessel was to start again for Boston in two hours, and that the mail for Pictou and Quebec would be off in less time still. Where the coach-office was, or what was to be done to get a place, or whether there were any places, or places enough for those who wished to go the Pictou way, were questions to which we could get no satisfactory answers, and I began to debate whether it would not be safer to go by way of Boston. Having, however, in

a short time, thanks to Mr. Deblois, and his nephew, who came on board to see him, obtained the requisite information, I secured a place to go by Pictou. I put my baggage into a truck, left the ship, and proceeded to the coach-office, where I paid £2 5s. for my seat, and 7s. for my baggage, over forty pounds weight."

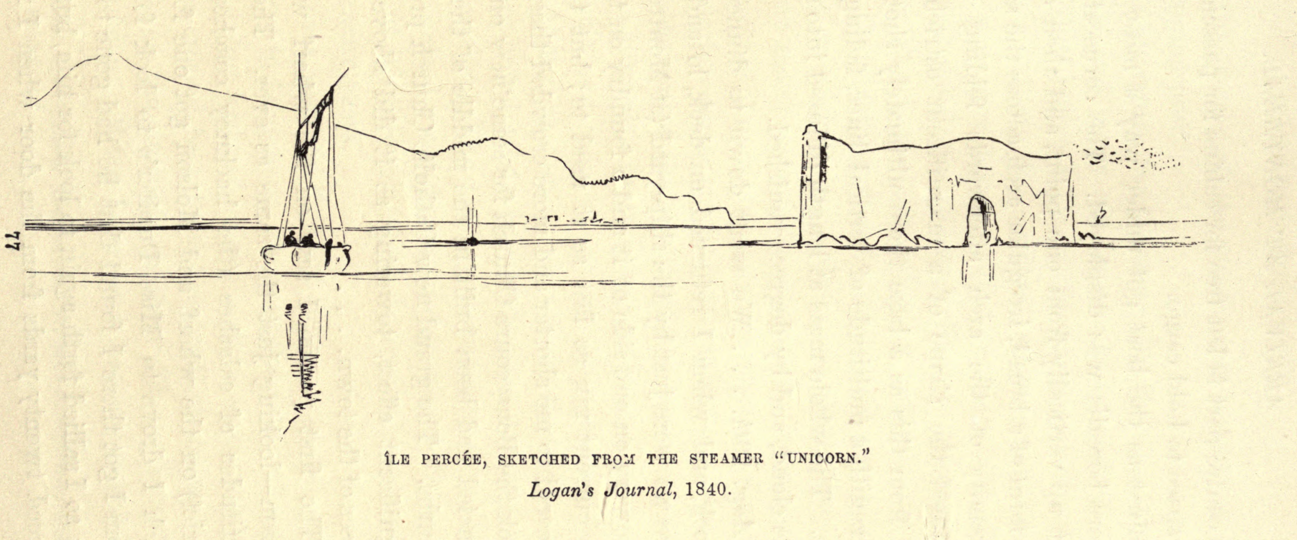
Forty years have elapsed since the occurrences of which we write, and now great ocean steamers ply up and down the beautiful harbour of Halifax almost unnoticed. There are no cheering thousands on the piers, for steamers have ceased to be a novelty; no eager multitude looking for the monthly mails from Europe. Now there are almost daily mails from continent to continent, and silent messages pass and repass along the Atlantic Cable, telling of far-off events almost as soon as they have transpired.

At nine o'clock on the evening of his arrival at Halifax, Logan left for Pictou. Crossing the harbour in a small boat, he found the coach-and-four in readiness at Dartmouth, and soon began his drive of 100 miles. "As it was a bright moonlight night," he says, "I determined to remain outside, in order that I might see something of the country; while my companion (Col. Balfour) determined to stay inside, in order that he might shut his eyes and have a view of the Land of Nod." In the morning, shortly before reaching the village of Truro, they met Sir Charles Fitzroy, Governor of Prince Edward Island, who stopped them in order to obtain the news. Logan informed him of the death of Lord Durham, late Governor of Canada, the elevation of Poulett Thompson to the Peerage, and other events in which he was likely to be interested. A son of Sir

George Seymour accompanied the Governor, and was gratified by hearing of his father's safe arrival at Halifax.

From Pictou to Quebec, Logan's journey was continued on board the steamer "Unicorn," which he recognized as one which had formerly plied between Liverpool and Glasgow. Arriving at Quebec on the afternoon of the 19th., he remained there but a few hours, and then left by the steamer "Canada" for Montreal, which was reached at five o'clock on the afternoon of the following day. Those who are familiar with the journey from Quebec to Montreal, and with the swift and commodious steamers by which it is now performed, will read with interest the following extract from Logan's journal of 1840 :—

"*Aug.* 19*th.* . . . At 7 p.m. embarked on board the "Canada," which is said to be one of the best steamboats on the river. It has a boiler and cylinder for each wheel, and there is no connecting spindle between the wheels; so that they revolve independently of each other. The beam of each engine is above the deck, and the two bob up and down in the most independent style, without any regard to regularity. One was going twenty strokes, while the other did not exceed eighteen per minute. We took a large barge in tow, and stopped alongside of a couple of brigs for the purpose of taking on board a lot of Irish and Scotch emigrants. I understand that 20,000 have come out this year. We got fairly away at nine o'clock, just as the evening gun was fired from the sloop-of-war, which is in port. The engines being on each side of the boat,



ÎLE PERCÉE, SKETCHED FROM THE STEAMER "UNICORN."
Logan's Journal, 1840.

the centre part is left free for cabins for passengers, and for space to hold cargo.

"Just as the boat got under way a most beautiful aurora borealis was displayed. The coruscations first shot up vertically from one point, and then spread in the form of a broad, irregular arch across the sky. One extremity of the arch afterwards folding round, it assumed the shape of a magnificent ostrich plume; and from this as a base there ultimately shot up into the zenith a multitude of vertical lines, fading as they rose. The whole mass at length diffused into a voluminous cloud, and by degrees vanished.

"*Aug.* 20*th*. . . . We went down to dinner at four o'clock, and when I returned on deck, lo and behold! there we were just by the ship-yard (at Montreal), with a brewery on one side of it and a foundry on the other. The current ran as fast as it used to; but the town appeared to me shorter and more crowded than of yore. I took the Bonsecours Church for some new one, which I fancied had been built in the middle of the Quebec Suburbs. The grand new Catholic Church produced a magnificent effect, towering as it did above all the houses of the town. . . .

"The first person I saw on the wharf was John Molson—looking just the same as ever. There were multitudes of calashes (the hackney coaches of the district) on the wharf, and Molson got one for me, in which I drove to Miss Dupirer's to look for James. When I got there I found that he had gone to look for me; so I sallied forth again to look for him, but did not proceed twenty yards from the door when I met him

turning the corner of the street, and looking as thin as a whipping-post."

On this his return to his native city, there were many old friends and many old haunts to be visited. The stores of Hart Logan & Co., on St. Sacrament Street and at Pointe à Callière, the old farm, where a new house* of stone was now being erected in the place of the old one of wood, the Natural History Museum, on St. James Street, the mineralogical collection of Dr. Holmes, the Lachine Canal—these and many other places he wished to see. But more important still, there were many rocks to be examined. Accompanied by his brother James, frequent geological excursions were made to various points in the vicinity of the city, and the relations of the stratified and eruptive rocks of the region studied. In this way a fortnight was pleasantly spent, and then he set out on a journey to the State of Maine, the object of which appears to have been to examine lands in which some of his friends were interested. The journey occupied several weeks, and was indeed a rough one, giving him a foretaste of the kind of life through which he was subsequently to pass for many years.

There was then no Victoria Bridge, and not even a steam-ferry to Longueuil. A steam-ferry had, it is true, been tried, but had not proved a success, and now the river was crossed by a horse-boat, which, owing to the swiftness of the current, required fifteen horses for its propulsion. From Longueuil Logan proceeded to

* This house subsequently became Sir William's residence, and was known as "Rockfield."

Sherbrooke by coach, and learning here that at a mountain known as the Carbuncle, not very far off, a vein of tin ore had been discovered, he determined to visit the locality, in order to ascertain whether there was any truth in the reports. "I left Sherbrooke," says his journal, "in a single-waggon at twelve, and passed over an undulating country of slate to Hops' tavern, at the upper end of Brompton Lake, where we arrived at two p.m. . . .

"About four p.m. we started, Hops, the driver, and myself, in a canoe made out of the trunk of a tree, and went down a small stream, still and deep, for five or six miles, and then came upon a lake, along the shore of which we continued our course. As we proceeded down the brook we raised a couple of ducks, but the driver, who had brought with him a long single-barrelled gun, could not get a shot at them. On the lake we heard the cry of an aquatic bird, which my friends informed me was a loon, and we came in sight of two of them; but they seemed very shy, as they dived and made off the moment they saw us approaching, while yet a long way off and wholly out of reach of shot. Their cry was very like a laugh, and it seemed to be a laugh at my friend the driver's gun.

"Just as it was getting dusk, we reached the shore of the lake at the point most convenient to make our ascent of the silver mountain, and, after securing the canoe, we hastened to find a spot convenient for camping on. This we discovered at a few rods from the shore, and immediately Hops proceeded to cut down some dry timber to get up a fire. Log after log

was heaped up, and very shortly we had a blaze sufficient to roast not one ox, but a dozen of them. Hops continued to ply his axe, at which he seemed very expert, and, having secured a sufficient quantity of soft wood, he cut down also a supply of maple and other hard woods to give the fire durability. This done, a quantity of hemlock boughs were strewn upon the moss near the fire, and we then quickly made ourselves a home for the night. We had no ceiling but the branches of the trees above us and the canopy of heaven; and as this canopy was a clear, bright blue, spangled with many stars, and illumined by the moon, without a cloud to show a chance of rain, we were content. Hops had brought some buckwheat cake, and when work was done his basket was produced, but I could not manage the cake. It seemed to me a cake of sand. So I rolled myself up in my mackintosh, and tried to sleep. But the wolves howled about us in all directions; so we sat up again, and began a set of stories and anecdotes about wolves and bears, which was quite enlivening. However, we became quiet by degrees, and dropped off to sleep, one after another. . . . The wolves howled all night long, but I slept pretty well notwithstanding, and when I awoke felt myself quite ready for our ascent. We started from our camp, and came upon a sort of path among the trees, which led us over fallen trunks and stones, and all kinds of entanglement and confusion, to the Carbuncle. No sooner did I put my eyes on some small pieces of the ore, than the tin turned out to be copper. Green carbonate and yellowish sulphuret are the kinds of

ore, but the lode does not seem worth working. . . . After examining all we could at the foot of the rock, we went round and attained its summit, clambering over moss-grown prostrate trunks, and moss-grown fragments of the rock itself; and from thence we had a magnificent view of the lake and the surrounding forest-covered hills. A mist was rising from the lake, but gradually cleared off, and we saw that other mists were rising from other lakes in the distance. One hovered over Massawippi, and one over Magog. Having supplied myself with specimens of the ore and of the rock of the mountain, we returned the way we came, visiting on the route a couple of small islands in the lake, one of which consisted almost wholly of serpentine, studded with oxydulated iron in crystals. Both were covered with a most delicious blueberry, on which I made my breakfast."

From Sherbrooke Logan continued his journey in gigs, carts, and waggons of every description; or where no vehicles were obtainable, on horseback, or even on foot. Having finally reached his destination in Maine, about the 20th. of September, and examined the lands which he had gone to see there, he returned by a different route, which brought him out to the St. Lawrence at Point Levis, opposite Quebec. Not knowing the hotels at the latter place, he requested the boatman with whom he crossed the river to conduct him to a good one, and was taken to the "Montreal," which the boatman said was "the best *auberge* in Quebec." In this opinion he did not long share; for, on entering, he saw that the guests were chiefly pilots,

and sailors from schooners. On wishing to retire for the night, he was shown into a room in which there were five beds, all of which, except one, which had been reserved for him, already had two occupants, sufficiently drunk to be in a mood for fighting. So noisy were they, in fact, that the people of the house soon threatened to call in the police, and Logan began to fear that he might be lodged in Quebec jail as one of the brawlers. "On getting up in the morning," he says, "daylight showed me a rare pig-sty of a house, which I made all haste to quit."*

Having returned to Montreal, he went in the following month to examine the effects of a land-slide, which had occurred a few months before on the River Maskinongé, below Montreal. The winter of 1840–41 was spent in Canada, and it was then that he made a study of the phenomena connected with the annual freezing over of the St. Lawrence. The facts obtained with reference to this subject and the landslide were afterwards embodied in an admirable paper which he read before the Geological Society of London in 1842, and much of which we reproduce here, as few have ready access to the original paper. It shows that he had become not only a careful and accurate observer, but also knew how to state clearly the results of his observations. Some years after, when George Stephenson, the engineer, undertook the construction

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* It was during this trip to Maine that Logan's attention was first drawn to the serpentines of the Eastern Townships. While at Quebec, also, he went over to Point Levis, and made his first examination of the rocks there.

of Victoria Bridge across the St. Lawrence, he is said to have obtained many useful hints from Logan's investigations, to which his attention was probably drawn through the Report of Mr. Thomas Keefer on the Bridging of the St. Lawrence (1853). In recommending what he considered as the best site for a bridge, Keefer supported his arguments by the observations of Logan, and Stephenson seems to have fully recognized the force of what they had both written on the subject.

On the Packing of Ice in the St. Lawrence, and on a Landslide in the Valley of the Maskinongé.*

[*Read June* 15*th.*, 1842.]

"The island of Montreal stands at the confluence of the Rivers Ottawa and St. Lawrence, and is the largest of several islands splitting up these mighty streams, which cannot be said to be thoroughly mingled until they have descended some miles below the whole cluster. The rivers first come in contact in a considerable sheet of water called Lake St. Louis, which separates the upper part of the island of Montreal from the southern main. But though the streams here touch, they do not mingle. The waters of the St. Lawrence, which are beautifully clear and transparent, keep along the southern shore, while those of the

* Quart. Journal of the Geological Society of London, Vol. ii. 1846, p. 422.

Ottawa, of a darker aspect, though by no means turbid, wash the banks of the island; and the contrast of colour they present strongly marks their line of contact for many miles.

"Lake St. Louis is, at the widest part, about six miles broad, with a length of twelve miles. It gradually narrows towards the lower end, and the river, as it issues from it, becoming compressed into the space of half a mile, rushes with great violence down the Rapids of Lachine, and, although the stream is known to be upwards of eight feet deep, it is thrown into huge surges of nearly as many feet high as it passes over its rocky bottom, which at this spot is composed of layers of trap extending into floors that lie in successive steps.

"At the termination of this cascade the river expands to a breadth of four miles, and flows gently on, until it becomes cramped up by islands and shallows opposite the city of Montreal. From Windmill Point and Point St. Charles, above the town, several ledges of rock, composed of trap, lying in floors, which in seasons of low water are not much below the surface, shoot out into the stream about 1,000 yards; and similar layers, pointing to these, come out from Longueuil on the opposite shore. In the narrow channel between them, the water, rushing with much force, produces the *Sault Normand*, and cooped up a little lower down by the island of St. Helen and several projecting patches of trap, it forms St. Mary's Current.

"The interval between St. Helen and the south shore is greater than that between it and Montreal; but the

former is so floored and crossed by hard trap rocks that the St. Lawrence has as yet produced but little effect in wearing them down, while in the latter it has cut out a channel between thirty and forty feet deep, through which the chief part of its waters rush with a velocity equal to six miles per hour. It is computed that by this channel alone upwards of a million of tons flow past the town every minute.

"Between this point and Lake St. Peter, about fifty miles down, the river has an average breadth of two miles, and, proceeding in its course with a moderate current, accelerated or retarded a little according to the presence or absence of shoals, it enters the lake by a multitude of channels cut through its delta, and forming a group of low, flat, alluvial islands.

"The frosts commence about the end of November, and a margin of ice of some strength soon forms along the shores of the river, and around every island and projecting rock in it; and wherever there is still water it is immediately cased over. The wind, acting on this glacial fringe, breaks off portions in various parts, and these, proceeding down the stream, constitute a moving border on the outside of the stationary one, which, as the intensity of the cold increases, is continually augmented by the adherence of the ice-sheets which have been coasting along it; and as the stationary border thus robs the moving one, this still further outflanks the other, until in some part the margins from the opposite shores nearly meeting, the floating ice becomes jammed up between them, and a night of severe frost forms a bridge across the river. The first

ice-bridge below Montreal is usually formed at the entrance of the river into Lake St. Peter, where the many channels into which the stream is split up greatly assist the process.

"As soon as this winter barrier is thrown across (generally towards Christmas), it of course rapidly increases by stopping the progress of the downward-floating ice, which has by this time assumed a character of considerable grandeur, nearly the whole surface of the stream being covered with it; and the quantity is so great that to account for the supply, many, unsatisfied with the supposition of a marginal origin, have recourse to the hypothesis that a very large portion is formed on and derived from the bottom of the river, where rapid currents exist. But whatever its origin, it now moves in solid and extensive fields, and wherever it meets with an obstacle in its course, the momentum of the mass breaks up the striking part into huge fragments that pile over one another; or if the obstacle be stationary ice, the fragments are driven under it, and there closely packed. Beneath the constantly widening ice-barrier mentioned, an enormous quantity is thus driven, particularly when the barrier gains any position where the current is stronger than usual. The augmented force with which the masses there move, pushes and packs so much below, that the space left for the river to flow in is greatly diminished, and the consequence is a perceptible rise of the waters above, which, indeed, from the very first taking of the bridge, gradually and slowly increase for a considerable way up.

"There is no place on the St. Lawrence where all the phenomena of the taking, packing, and shoving of the ice are so grandly displayed as in the neighbourhood of Montreal. The violence of the currents is here so great, and the river in some places expands to such a width, that whether we consider the prodigious extent of the masses moved, or the force with which they are propelled, nothing can afford a more majestic spectacle, or impress the mind more thoroughly with a sense of irresistible power. Standing for hours together upon the bank overlooking St. Mary's Current, I have seen league after league of ice crushed and broken against the barrier lower down, and there submerged and crammed beneath; and when we reflect that an operation similar to this occurs in several parts from Lake St. Peter upwards, it will not surprise us that the river should gradually swell. By the time the ice has become stationary at the foot of St. Mary's Current, the the waters of the St. Lawrence have usually risen several feet in the harbour of Montreal, and as the space through which the current flows affords a deep and narrow passage for nearly the whole body of the river, it may well be imagined that when the packing here begins, the inundation rapidly increases. The confined nature of this part of the channel affords a more ready resistance to the progress of the ice, while the violence of the current brings such an abundant supply, and packs it with so much force, that the river, dammed up by the barrier, which in many places reaches to the bottom, attains in the harbour a height usually twenty, and sometimes twenty-six feet above

its summer level; and it is not uncommon between this point and the foot of the current, within the distance of a mile, to see a difference in elevation of several feet, which undergoes many rapid changes, the water ebbing or flowing according to the amount of impediment they meet with in their progress from submerged ice.

"It is at this period that the grandest movements of the ice occur. From the effect of packing and piling, and the accumulation of the snows of the season, the saturation of these with water, and the freezing of the whole into a solid body, it attains the thickness of ten to twenty feet, and even more; and after it has become fixed as far as the eye can reach, a sudden rise in the water, occasioned no doubt in the manner mentioned, lifting up a wide expanse of the whole covering of the river, so high as to free and start it from the many points of rest and resistance offered by the bottom, where it had been packed deep enough to touch it, the vast mass is set in motion by the whole hydraulic power of this gigantic stream. Proceeding onward with a truly terrific majesty, it piles up over every obstacle it encounters; and when forced into a narrow part of the channel, the lateral pressure it there exerts drives the bordage up the banks, where it sometimes accumulates to the height of forty or fifty feet. In front of the town of Montreal there has lately been built a magnificent revêtement wall of cut limestone to the height of twenty-three feet above the summer level of the river. This wall is now a great protection against the effects of the ice. Broken by it, the ice

piles on the street or terrace surmounting it, and there stops; but before the wall was built, the sloping bank guided the moving mass up to those of gardens and houses in a very dangerous manner, and many accidents used to occur. It has been known to pile up against the side of a house more than two hundred feet from the margin of the river, and there break in at the windows of the second floor. I have seen it mount a terrace garden twenty feet above the bank, and crossing the garden enter one of the principal streets of the town. A few years before the erection of the revêtement wall, a friend of mine, tempted by the commercial advantages of the position, ventured to build a large cut-stone warehouse, 180 feet long and four or five stories high, closer than usual upon the margin of the harbour. The ground-floor was not more than eight feet above the summer level of the river. At the taking of the ice, the usual rise of the water of course inundated the lower story, and the whole building becoming surrounded by a frozen sheet, a general expectation was entertained that it would be prostrated by the first movement. But the proprietor had taken a very simple and effectual precaution to prevent this. Just before the rise of the waters, he securely laid against three sides of the building, at an angle of less than 45°, a number of stout oak logs, a few feet asunder. When the movement came, the sheet of ice was broken and pushed up the wooden inclined plane thus formed, at the top of which, meeting the wall of the building, it was reflected into a vertical position, and falling back, in this manner such an enormous rampart of ice was in

a few minutes placed in front of the warehouse, as completely shielded it from all possible danger. In some years the ice has piled up nearly as high as the roof of this building. Another gentleman, encouraged by the security which this warehouse apparently enjoyed, erected one of great strength and equal magnitude on the next water lot, but he omitted to protect it in the same way. The result might have been anticipated. A movement of the ice occurring, the great sheet struck the walls at right angles, and pushed over the building as if it had been a house of cards. Both positions are now secured by the revêtement wall.

"Several movements of the grand order just mentioned occur before the final setting of the ice, and each is immediately preceded by a sudden rise of the river. Sometimes several days, and occasionally but a few hours, will intervene between them; and it is fortunate that there is a criterion by which the inhabitants are made aware when the ice may be considered at rest for the season, and when it has therefore become safe for them to cut their winter roads across its rough and pinnacled surface. This is never the case until a longitudinal opening of considerable extent appears in some part of St. Mary's Current. It has embarrassed many to give a satisfactory reason why this rule, derived from the experience of the peasantry, should be depended on. But the explanation is extremely simple. The opening is merely an indication that a free sub-glacial passage has been made for itself by the water, through the combined influence of erosion and temperature, the effect of which, where the current is strongest, has been

sufficient to wear through to the surface. The formation of this passage shows the cessation of a supply of submerged ice, and a consequent security against any further rise of the river to loosen its covering for any further movement. The opening is thus a true mark of safety. It lasts the whole winter, never freezing over, even when the temperature of the air reaches 30° below zero of Fahrenheit; from its first appearance the waters of the inundation gradually subside, escaping through the channel of which it is the index. The waters seldom or never, however, fall so low as to attain their summer level; but the subsidence is sufficiently great to demonstrate clearly the prodigious extent to which the ice has been packed, and to show that over great occasional areas it has reached to the very bottom of the river. For it will immediately occur to everyone, that when the mass rests on the bottom its height will not be diminished by the subsidence of the water, and that as this proceeds, the ice, according to the thickness which it has in various parts attained, will present various elevations after it has found a resting-place beneath, until just so much is left supported by the stream as is sufficient to permit its free escape. When the subsidence has attained its maximum, the trough of the St. Lawrence therefore exhibits a glacial landscape, undulating into hills and valleys that run in various directions, and while some of the principal mounds stand upon a base of five hundred yards in length, by a hundred or two in breadth, they present a height of ten to fifteen feet above the level of those parts supported on the water. . . .

"The country to a considerable distance on both banks of the St. Lawrence, from Montreal to Lake St. Peter, and even to Quebec, is very level, and it is in general covered with a deep and highly levigated deposit of argillaceous, arenaceous and calcareous matter, the constituents of which vary in their proportions in different localities. This deposit rests upon a shallow trough of black shale and black and grey limestone, the fossils of which are palæozoic, and resemble those figured as belonging to the Lower Silurian rocks of Britain. This trough is bounded on the N. W. side by a range of moderately elevated granitic and syenitic hills, which rise up without tilting or much disturbing the limestone, and follow the river all the way to Quebec; and from below the limestone on the S. E. there crops a hard quartzose conglomerate, succeeded by a formation of pyritiferous clay slate, with a cleavage cutting the layers of deposit in a N. E. and S. W. direction, which is that of their general strike. The bounding rocks on both sides of the trough present a surface undulating into hill and dale, and those on the S. E. give rise to a picturesque country, very much resembling some of the slate counties of Wales. The plains between them covering the trough constitute the valley of the St. Lawrence, and may occupy a breadth of forty miles, and the nature of the material of which they are composed renders it impossible to conceive a region more fitted for the purposes of agriculture.

"Between Montreal and Lake St. Peter, the plains on the south side of the river do not appear to attain the

elevation they exhibit on the N. W. Occasionally so low, close by the margin of the stream on both sides, as to allow the formation of marshes, the banks in general present a height of twenty to thirty feet above the level of the water; but on the N. W. side, and ranging with the river, at a distance varying from one to six miles from the water's edge, there occurs a sudden upward step in the land of about 100 feet, forming an elevated terrace between this point and the granitic country already mentioned, which rises up in another step, and though undulating in the interior, has a general additional elevation of 200 to 300 feet.

"The terrace at the foot of the granitic step has a very even surface over a great area, slightly modified in a few places by the protrusion of the underlying limestone through the soft deposit of which it is composed. It is chiefly, however, in the beds of the rivers which cross the plain in their course to the St. Lawrence that the limestone strata are visible; and some of these tributaries, dashing down the side of the granitic step, cut at once into the terrace below, very nearly to the level of the main stream, and winding through the deposit in question, show it to possess considerable depth. When any tributary has excavated so deep a passage, the banks are occasionally subject to landslips, sometimes of a very serious character, and having visited the scene of one on the banks of the Maskinongé, it appears to me worthy of particular notice.

"The waters of the Maskinongé take their rise in a chain of mountains to the N. W., and passing through a series of small lakes, fall into one about nine miles in

circumference, bearing the same name. Issuing thence, they flow through about twelve miles of country before they are precipitated in a beautiful cascade down the side of the granitic step on to the plain at its foot. Making a deep section into this, they wash bare the outcrop of some limestone strata, which exhibit a gentle dip of 3° to 4° southward; and from this point to the mouth of the tributary at the head of Lake St. Peter, there is very little fall, with the exception of a spot six miles below the cascade, where there is an accumulation of large boulders, evidently derived from the granite further up. At this spot, a mill dam across the stream occasions a fall of about fifteen feet, which, with a very small addition, will represent the whole amount of descent in the river from the granite hills to the lake receiving it, a distance of twelve miles.

"The general course of the river is from N. W. to S. E., with, however, a few meanderings. Where the landslip occurred, about nine miles below the cascade, the stream is from ten to twenty yards wide. Flowing nearly south, it suddenly turns to the west, and running in that direction for about 700 yards, it again turns direct south. The valley in which it winds its way is of uniform breadth, the summit of the banks being about 200 yards apart. The banks, as may be inferred from what has been said, are about 120 feet high, and the landslip in question took place on the right bank, in the middle of the western turn mentioned.

"On the 4th. of April, 1840, while the snows of winter were yet upon the ground, about eight o'clock in the

morning, the inmates of the farm-houses on the spot were alarmed by the agitation of their wooden dwellings, and looking from the windows, became aware from changes in the relative positions of the trees in the neighbourhood, that the ground on which they stood was in motion. They, of course, quitted their homes with precipitation, and fled in great terror to rouse the country around, and the confusion and dread which the event occasioned while in progress, disabled the population from making very accurate observations of the phænomena with which it was accompanied; but from an examination and survey of the spot after it had happened, and such accounts as I could collect, it would seem that a mass of the soft deposit, covering the solid rocks, about 200 yards wide and 700 yards long, but how deep is uncertain, slipped out of the bank endways towards the river. This was followed in quick succession, at intervals of a few minutes, by four others, occupying with the first an area of about eighty-four acres, of an irregular form, somewhat resembling the section of a long-necked flask, the whole length of which was 1,300 yards, and the widest part, removed a considerable way back from the river, was 600. The contents of this huge trough, consisting of a marly clay, slipped out at the long, narrow spout where the movement began, crossed the river, struck the opposite bank, and splitting into two parts, one-half proceeded up the stream about three-quarters of a mile, the other an equal distance down, and thus completely blocked up the valley for half a league. The whole operation was completed in about

three hours, and for a considerable time after it began the surface of great patches of the moving mass continued unbroken. More than half the amount was covered with fine sugar-maple trees, and these for the most part travelled in an erect position on the surface of the earthy deluge, as it poured both ways through the valley; but occasionally a tree or two in different places would be prostrated, and a few, caught below, were crushed and engulfed. Two farmsteads were carried away, and though the people escaped, horses, cows and sheep were not so fortunate. Those remaining shut up in the stables perished with them, as the houses one after another were crushed and sunk in various places. But of the poultry, two hens, and also a cock that was heard to crow most lustily as the mansion in which he was cooped up sailed along, were found alive after the event.

"The masses that blocked up the valley travelled with a height of about sixty feet, and while their surface was slightly culminated, the front of each terminated in a blunt point projecting in the middle and lower part. As these great double-acting ploughshares were propelled along, they turned up the soft mud from the bed of the river, casting it on the bank on each side; and the stench which arose during the operation, caused probably by the disengagement of sulphuretted hydrogen from the decaying vegetables displaced, was so utterly intolerable, that no one could approach the river to within 100 yards. Where the first mass struck the opposite bank, the height it attained was seventy-five feet, and from this the culminating ridges gradually

recurred until they gained a position in the middle of the valley, gradually lowering also until they reached the height of sixty feet, as above mentioned.

"No sooner was the valley thus blocked up than the water above the impediment began to rise. Houses, logs and planks, and indeed everything composed of wood, were set afloat for nine miles up, being as far as the granite hills. But it was two days before the lake thus formed attained a sufficient height to overtop the obstacle. The water first found an escape by the gulley. between the original bank on the left and the slope on the east side of the culminated impeding mass, making a slight detour where favoured by a depression through a wood round the point where the launch first struck the bank in question; and its erosive action thus put into operation was sufficient, in the course of six months, to carry away nearly the whole of the clay lodged in the valley. The quantity must have been several millions of tons; and in the month of October so much had been swept into Lake St. Peter, that the Maskinongé above the slip was then not more than ten feet beyond its ordinary depth.

"Though the surface of the great area disturbed remained for some time unbroken after the general movement began, it gradually sunk as this continued, and at the period I saw the place, in the subsequent autumn, the bottom of the chasm was thirty feet below the level of the surrounding country, while about 400 yards from the river there was a sudden descent of fifteen feet more, from which the ground sloped gently to the water's edge. There was then very little of the original

surface to be seen. Here and there was visible a small grass-covered patch, and occasionally there might be seen, still entire, twenty or thirty yards of the wooden fence used in the country for the divisions of property. But nearly the whole area exhibited the greatest confusion, being thrown up into a multitude of parallel clay hillocks, from three to four feet high. No doubt these mounds were occasioned by the pressure of mass against mass in the direction of motion, at right angles to which would be their greatest diameter. From the shape of the mounds, it appeared that the motion of the landslip must have been down the middle of the chasm towards the river, and from the sides to the centre.

"A circumstance connected with the form of the area affected by the slip appears singular. The ground moved constituted part of the general plain of the neighbouring country; but on all sides of it, with the exception of the northern extremity, there was a depression in the surface, between which and the chasm produced, there remained after the slip a narrow ridge at the original height, forming a bounding rim to the cup which the chasm presented. The depression on the east side was formed by the slope of the right bank of the river, and an offset or bay of lower land than the general plain of the country, and on the west by a dingle furnished with a brook. The rim was not many feet wide on the top, but its parallelism to the depression was remarkable, and it was only broken through in one place, where a tributary dingle had joined the one on the west.

"It would not be very difficult to prove that there is scarcely any other mode of satisfactorily accounting for the movement of this mass of land than its pressure on an inclined surface, assisted by the action of water on some bed below. The layers of the deposit itself appeared all perfectly horizontal: the slip, therefore, could not have been on one of them. But the dip of the underlying limestone, wherever I could detect its appearance for miles around, was precisely in the direction of the slip, with an inclination of about 4°; and although none of it was visible near the spot, I am persuaded it could not be very deep below the bottom of the river. It is highly probable that the surface of one of its beds presented the plain which gave occasion to the launch. Supposing any boulders to exist at the bottom of a deposit moved in the manner described, it is easy to see that parallel grooves and a polish on surfaces of rock may not, in all cases, be attributable to the agency of ice. . . ."

CHAPTER VII

PENNSYLVANIA AND NOVA SCOTIA.

On the 11th. of August, 1841, Logan left Montreal with the intention of returning to Britain by the first packet from New York; but his plans were subsequently changed, and as we shall see, he remained in America until the 8th. of October. The journey from Montreal to New York was in those days, to say the least, a tedious one, and even in summer, when water communication could be taken advantage of to the fullest extent, occupied several days, instead of about fifteen hours, as at present. The luxurious traveller of to-day enters a "Pullman" or a "Wagner" at Montreal in the evening, and the following morning wakes up in New York; but look at the journey of forty years ago: Montreal to Laprairie by boat; Laprairie to St John's, on the Richelieu, by wooden railway; thence by steamer through Lake Champlain to Whitehall; from Whitehall to the Hudson, by canal-boat, and, finally, down the Hudson to New York by steamer. No wonder that, with so many changes,

Logan lost his hat-box. Travelling by canal-boat was a new experience to him, and afforded him no little amusement. The Whitehall Canal, he tells us, was crossed by a great number of bridges, so low that it was necessary to look out sharply when on deck to prevent your head from being knocked off. On approaching a bridge, the helmsman called out "bridge," or sometimes "low bridge," and all on deck were flat in an instant.

On arriving at New York, Logan, and a pet turtle which he carried with him, took up their quarters at the Astor House. This was the fashionable hotel of the day, and with its proportions and grandeur he was much astonished. With reference to it, an entry in his journal says: "It is certainly a most magnificent establishment. The front and the north side are of granite, and the building looks more like a palace than a hotel. To-day there have been 192 arrivals. The number of my bedroom is 237. I daresay there may be 300 bedrooms in the house." Finding that a gentleman with whom he had business to transact was absent from the city, he determined to postpone his return to England until the next packet, and meantime to visit the coal-fields of Pennsylvania, and, if possible, that of Pictou, in Nova Scotia. While hurrying along the street, busied with preparations for his journey to Philadelphia, he was not a little surprised at seeing Lyell, the geologist, who happened at this very time to be travelling in America. "I had," says the modest Logan, "a huge inclination to go up and speak to him, but did not, like a fool as I am. However, I have found

that he is at the Astor House, and have, therefore, determined to stop until Monday, and endeavour to have an interview with him." In this he succeeded, as will be seen from the following entries in his journal:—

"*Sunday, August 15th.*—I met Mr. Lyell in the lobby this morning, and introduced myself to him. He knows me very well, I find, and immediately, to my great gratification, spoke of my interesting (as he termed it) paper on underclays, and Buckland's confirmation of my facts. He says he means to notice the paper at some length in the next edition of his work. He introduced me to Mrs. Lyell, and said he would call at my room in the course of the day. . . . I saw Mr. Lyell after dinner, and had about an hour's conversation with him. He considered several of the facts I mentioned with regard to the changes of quality in our Welsh coal-field as very striking and beautiful. I took tea with him and Mrs. Lyell, who is a most lady-like person. She is a daughter of Leonard Horner. Mr. Lyell starts to-morrow morning for Albany. He means to visit Canada in the spring. He considers the discovery that I have made there of fishes' teeth in the limestone of great importance."

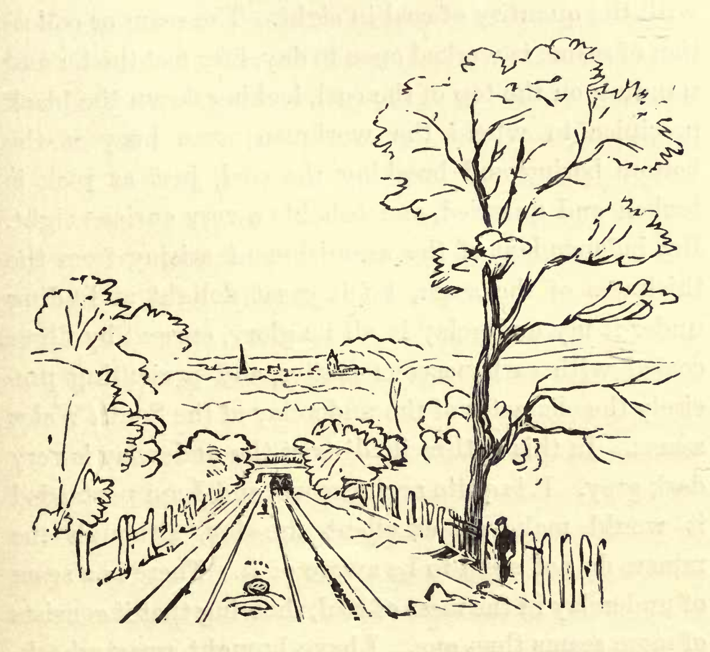
The following day he wrote to his brother James, telling him of Lyell's intended visit to Canada, and urging him to make collections of organic remains with which to delight the great geologist on his arrival. "Lyell," says the letter, "will be in Montreal some time in the spring, and if you in your leisure walks will make a collection of all the organic remains you can for

him, you will not only be serving him, but also the cause of geology. It is not necessary that a man should be a geologist to make a collection. All that you have to do is to note the locality with some accuracy, and the best way to do this is to put a number on the specimen and a mark on the map of Montreal, of which you can get a copy at Fabre's. Keep the specimens distinct, so that no confusion may arise when you come to point out whence each is derived.

"The shells in the clay should also be collected, and you should endeavour to ascertain as nearly as possible the height of each locality above the level of the water in the harbour."

Having gratified his desire to meet the distinguished Lyell, Logan left the following day for Philadelphia, and in his journal we find the following entry: "At half-past three reached Philadelphia. The buildings on the water-side are all of brick. After walking about the town for a couple of hours, I find that one street is so like another that it is unnecessary to take more trouble to see the whole. Those I have seen are probably a good sample of the rest. Chestnut Street contains the best shops and is *the* street of the town. It is the Philadelphia Broadway or Bond Street. The hotel at which I am is on the said street, and goes by the title of Congress Hall. It does not, however, seem to be any better conducted than Congress itself, and is on the whole rather a shabby affair. I came to it on the recommendation of a blackey on board the steamboat. I have been to two booksellers' after Silliman's account of the Pennsylvania coal-fields, but cannot find

it. . . . There are in Philadelphia some marble buildings that look remarkably well. The U. S. Bank is one of them. . . . The streets in general are not very wide. They are all at right angles to one another, dividing the town into rectangular blocks. The town is lighted with gas, and cuts a respectable figure by night. Everything, however, is more neat than grand."



INCLINED PLAIN ON THE PHILADELPHIA AND BALTIMORE RAILWAY, LOOKING DOWN TOWARDS PHILADELPHIA.
Logan's Journal, 1841.

Eager to get a glimpse of the coal-fields, and to ascertain whether the Stigmaria underclays, in which he was so much interested, occurred beneath the coal-seams of Pennsylvania, he hastened on to the Pottsville

region. Here he spent several days; but finding the opportunities of seeing the underclays rather poor, owing to the galleries being cut chiefly in the coal, he proceeded to Mauch Chunk. "Immediately on arriving here," says his journal, "I sallied forth for the coal mines, which are about half a mile from the Summit Hotel. On seeing them I certainly was greatly struck with the quantity of coal in sight. The seam or collection of seams is worked open to day, fifty feet thick; and standing on the top of the coal, looking down the black precipice to where the workmen were busy at the bottom boring and breaking the coal, just as rock is broken and quarried, one beholds a very curious sight. But independent of the astonishment arising from the thickness of the seam, I felt great delight at finding under it my underclay in all its glory, crossed by fibres coated with carbonaceous matter, and presenting precisely the character of the underclay of the South Wales seams. In this anthracite district the underclay is very dark grey. It is quite argillaceous, and I am persuaded it would make an excellent fire-clay, although the miners do not seem to be aware of it. There is a seam of underclay in the mass of coal, showing that it consists of more seams than one. I have brought away whacking specimens of each, but I shall return to-morrow to look after more.

"At 5.30 p.m. we got into the railway-car, and in twenty minutes ran down to Mauch Chunk by an inclined plane, which carried us down 1,000 feet in eight miles. The flight down this Montagne Russe strikes one as being very odd. Away the car goes, without

either steam or horse-power, slow in its motion at first, but gradually increasing in speed, until a rapidity of about twenty-five miles an hour is attained. The vehicle seems instinct with life, and one feels as if on a horse which is running away. The conductor has power over a friction-strap, by which he can diminish the rate of speed, but there are many short turns on the road, and as the track is single, the descending car might happen to come in contact with an ascending train as it is drawn up by mules. A pretty concussion would ensue. A good deal of skill is displayed in placing the rails at the turns. The outside rail of the sweep is always higher than the other, to preserve the equilibrium of the rapidly-descending car. Accidents have happened on the road; pigs, cows, and men have been run over and killed. A deaf and dumb man, lying drunk on the rail, was cut in two.

"The coal is carried down this road from the mine at Summit Hill, and the whole train, consisting of sometimes seventy waggons, descends in four divisions in about thirty minutes. The empty waggons are drawn up by mules, ten mules to each sixteen waggons. The mules are, of course, brought down the incline in cars —riding like gentlemen, not pulling like horses. It is amazing to see with what sagacity they take their places, both in entering the cars to descend and in dismounting at the bottom of the incline. The Company, called the *Lehigh Coal Company*, has 300 mules for the performance of the work, which is so hard that horses could not stand it.

"The operations of this Company have been crippled by a tremendous freshet, which occurred in the month of January last. The water of the Lehigh rose above all former marks, and swept away mills, bridges, dams, houses, and all description of materials. The Company lost $300,000 in destruction of standing works, independent of the injury which has been sustained by the interruption of the navigation, and the consequent suspension of their trade, which may be estimated at $100,000 more. Three mills were swept away from a point immediately in front of the Mauch Chunk Hotel, in which I have taken up my quarters.

"Mauch Chunk is remarkably situated, in a deep valley, with grand and lofty mountains of conglomerate and red shale rising up abruptly from the River Lehigh, which flows through it. Day is almost shut out from the town, and looking down upon it from the high point above, where the car stopped, it seemed buried amid rocks and woods."

After Mauch Chunk, Wilkesbarre was visited, and a week fully occupied in examining the coal-measures of that interesting district. A geological section, extending across the coal-field for a distance of about four miles, was made, and coal discovered where its existence had not previously been known. In this work he obtained much valuable assistance from Capt. Bowman, a gentleman whom he had the good fortune to meet at Wilkesbarre. His journal for the week contains little besides geological measurements, but on the 31st. of August, the day before leaving Wilkesbarre, he made the following entry :—

"Though I have not kept a registration of days in my journal since my arrival at Wilkesbarre, yet there is evidence enough in it that I have not been idle. Capt. Bowman, to whom I was introduced on my arrival, has been my right-hand man, and has given me very great assistance in making a section of the measures of this great Wyoming coal-field, and in obtaining good specimens of underclay. He is a man of talent, and a gentleman. He took a high prize at West Point University, and is esteemed a good officer in the United States Service. I have given him a hint or two that may enable him to make money in coal.

"Coal speculations in this valley might be made to very great profit. The mineral is just beginning to obtain a vent. It is only lately that a canal has been made to convey the produce of the mines to the sea-board, and several good collieries have been established. Capt. Bowman is opening one in the 24-feet seam, which cannot fail to be profitable. The farmers, however, do not yet know the nature of coal-ground, and have not much idea of the constancy of coal-seams. When they do not see coal, they scarcely believe it will be found on their field because it is on the next one and running towards it. The consequence is that they will sell their lands at a little more than the value of the surface. Any one making himself master of this coal-field, which is pretty extensive, and keeping his eye on the points from which an easy exit might be obtained, could scarcely fail to make money if he had capital to invest. I rather think Capt. Bowman has opened his eyes to this fact. Being an engineer, he will soon be

able to unravel the secrets of the stratification of the district.

"Under every seam of coal that I have seen I have found my underclay. There is one, however, in —— Gully, which some may think an exception. I fancy it is not; for though the lowest rock is hard and compact, I think I see the carbonaceous streaks that indicate *Stigmaria.*"

Sufficient had now been seen by Logan to convince him that the views which he had held concerning the Welsh coal-seams and their underclays were equally true with regard to those of Pennsylvania. Accordingly he decided not to prolong his stay further, but to return at once to New York, complete his business there, and then proceed by way of Boston to Nova Scotia. With the importance of the Pennsylvania coal-fields he was greatly impressed. "Such a sight," he writes, "as the Lehigh mines present, is to a collier overwhelming. Imagine a seam of coal fifty feet thick, with its covering taken off for a space of 500 or 600 yards square, and worked to open day like a quarry!—cut into great precipices and ravines, and giving to the eye a picture as black as Erebus." And again: "When it is recollected that with the coal are associated vast veins and seams of iron ore, and huge beds of limestone, it would seem as if Providence intended that Virginia, Pennsylvania, and Ohio should become the workshops of the world. The wealth that these three States will, in the course of of a quarter or half a century, arrive at, is incalculable."

Logan even talked of settling in the United States as a coal-viewer; but in reality his heart was already set

upon the almost vacant geological field which Canada afforded. While in Philadelphia, on his way back to New York, he met with Dr. Rogers, of Virginia, and in the course of conversation mentioned to him his desire to undertake a geological survey of his native Province. Only a few days after this, also, he wrote to one of his brothers saying, "I have almost made up my mind, if I can make the necessary arrangements in business matters, to offer myself as a candidate to undertake the survey of Canada, and if I once begin, it will not be my fault if it does not go ahead." No doubt his wish to take this great work in hand was stimulated by his meeting members of both the Pennsylvania and New York Surveys, and seeing how much had already been accomplished by them.

On his return to New York, Logan's business engagements detained him for several days; but still he was determined not to go back to England without seeing the Pictou coal-field. On his way thither Boston was visited. "We crossed," says his journal, "a sheet of water on a long, low, narrow bridge, and entered Boston at 11.45. I got my baggage, and gave it to the first cabman who appeared. He had 'Marlboro'' on his hat; so to the 'Marlboro' Hotel he took me, and there I find myself in a small room, number 43. The regulations of the house are rather odd for an hotel: Prayers at 9.30 p.m.; prayers at 6.30 a.m. No spirituous liquors; no cooking on Sunday; no payment received on Sunday; grace before meat at the ordinary, both at dinner and tea, and I suppose at breakfast."

Although only a day was spent in Boston, the beauties of the place did not fail to excite Logan's admiration, and in his journal we find the following description :—

"Boston is certainly a grand city. I went to the look-out on the cupola of the State House, and thence had a magnificent view. The main part of the city (called North Boston) was down below me, consisting of parks and trees, and thousands upon thousands of substantially-built brick houses, studded with spires, cupolas, and edifices taller than others, and surrounded with wharves, quays, and docks, all on a peninsula joined to the mainland by a low, narrow neck, and to South Boston (standing on another peninsula) by two long, very low, narrow bridges. From many points landward, also, there stretched to North Boston sundry other long, low, narrow bridges, over salt marshes and shallow waters, for the purposes of common roads and railroads. And then there was East Boston on another peninsula, joined to North Boston and to the mainland by still another set of long, low bridges. Seaward were a multitude of islands and capes, completely locking in the harbour, on whose bosom floated ships of war and ships of trade, some at anchor and some in motion, and steamboats, great and small, sending their black smoke and their hissing white smoke in clouds aloft, some coming and some going. Into the shallow water to the west a couple of quiet rivers flowed, giving perspective to the middle distance by their converging shores, on which were country seats peeping out from embowering woods. . . . To the south an

outline of hills, which came up sharply against the sky, showed in their eastward course that the rocks which compose them have been the barrier which protects from the attacks of the ocean the promontory that chiefly shields the bay.

"Up from the city came a busy hum, with the noise of clattering hoofs and rattling carriages, the clinking of hammers and the ringing of bells, mingled with the cries of trade and the barking of dogs; and ever and anon a cock would crow his note of defiance, to be answered by another. Men looked like pigmies in the streets below, and it seemed impossible that such little creatures could be the authors of such great works as were spread around.

"North Boston is like the body of a great spider, and all the long, narrow bridges that emanate from it look like the spider's legs."

Leaving Boston by steamer, on the 11th. of September, Logan proceeded to St. John, in New Brunswick, and then crossing the Bay of Fundy, arrived at Windsor, in Nova Scotia. At St. John he had hoped to meet Dr. Gesner, the author of a number of reports on the geology of New Brunswick; but in this he was disappointed, for Gesner was absent on a geological excursion to Miramichi. The geology of Windsor and its vicinity appeared so enticing to Logan that he could not pass it by, but resolved to remain there for several days. At that time Judge Haliburton, the author of "Sam Slick," resided near the town, and worked the extensive deposits of gypsum that occurred on his property. His quarries being in sight of the inn, attracted

Logan's attention, and on going to examine them, he encountered the author himself, and began to ply him with questions about the geology of the neighbourhood. "The Judge," he says, "answered them as well as he could, but evidently he is not deep in the mysteries of stratification. He, however, gave me some local information that was very useful in respect to quarries where I might gather fossil remains."

On the wharf at Windsor some building-stone happened to be lying. To the ordinary observer, no doubt, it was so much building-stone, and nothing more; but there was something about it which excited Logan's interest, and made him desire to see the locality from which it had been derived. On enquiry, he learned that it came from Horton Bluff, about fifteen miles off; and so to Horton Bluff he went. The rocks there belong to the Lower Carboniferous formation, and Logan was rewarded by finding in one of the beds the tracks of a batrachian animal. The discovery was one of great importance, as it was the first instance in which any evidence had been obtained of the existence of such animals at so early a period in the history of our globe. At the time, however, it failed to attract the attention which it deserved, and the credit of making the first observations of the kind fell to others. It is right, therefore, that the facts of the case should be noticed here, and we give them as stated by Dr. Dawson, in his work on the "Air-Breathers of the Coal Period," published in 1863:—

"It has often happened to geologists, as to other explorers of new regions, that footprints in the sand

have guided them to the inhabitants of unknown lands. The first trace ever observed of reptiles in the Carboniferous system, consisted of a series of small, but well-marked footprints, found by Sir W. E. Logan, in 1841, in the lower coal-measures of Horton Bluff, in Nova Scotia; and as the authors of all our general works on geology have hitherto, in so far as I am aware, failed to do justice to this discovery, I shall notice it here in detail. In the year above mentioned, Sir William, then Mr. Logan, examined the coal-fields of Pennsylvania and Nova Scotia, with the view of studying their structure, and extending the application of the discoveries as to *Stigmaria* underclays which he had made in the Welsh coal-fields. On his return to England, he read a paper on these subjects before the Geological Society of London, in which he noticed the discovery of reptilian footprints at Horton Bluff. The specimen was exhibited at the meeting of the Society, and was, I believe, admitted on the high authority of Prof. Owen, to be probably reptilian. Unfortunately Sir William's paper appeared only in abstract in the Transactions; and in this abstract, though the footprints are mentioned, no opinion is expressed as to their nature. Sir William's own opinion is thus stated in a letter to me, dated June, 1843, when he was on his way to Canada, to commence the survey which has since developed so astonishing a mass of geological facts:

" 'Among the specimens which I carried from Horton Bluff, one is of very high interest. It exhibits the footprints of some reptilian animal. Owen has no

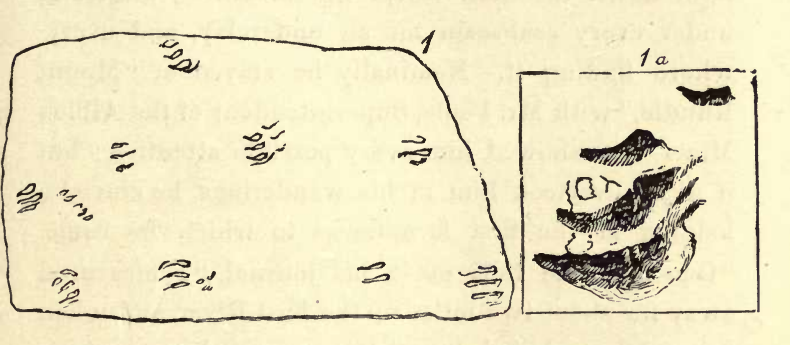
doubt of the marks being genuine footprints. The rocks of Horton Bluff are below the gypsum of that neighbourhood; so that the specimen in question (if Lyell's views are correct*) comes from the very bottom of the coal series, or, at any rate, very low down in it, and demonstrates the existence of reptiles at an earlier epoch than has hitherto been determined; none having previously been found below the magnesian limestone, or, to give it Murchison's new name, the Permian era.'

"This extract," continues Dr. Dawson, "is of interest, not merely as an item of evidence in relation to the matter now in hand, but as a mark in the progress of geological investigation. For the reasons above stated, the important discovery thus made in 1841, and published in 1842, was overlooked; and the discovery of reptilian bones by Von Dechen, at Saarbruck, in 1844, and that of footprints by Dr. King, in the same year, in Pennsylvania, have been uniformly referred to as the first observations of this kind. This error I now desire to correct, not merely in the interest of truth, but also in that of my friend, Sir William Logan, and of my native Province of Nova Scotia; and I trust that henceforth the received statement will be, that the first indications of the existence of reptiles in the coal-period were obtained by Logan, in the Lower Coal formation, in 1841. Insects and arachnidans, it may be observed, had previously been discovered in the Coal formation in Europe.

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* Sir Charles Lyell had then just read a paper announcing his discovery that the gypsiferous system of Nova Scotia is Lower Carboniferous, in which he mentions the footprints referred to as being reptilian.

"The original specimen of these footprints is still in the collection of Sir William Logan. It is a slab of dark-coloured sandstone, glazed with fine clay on the surface, and having a series of seven footprints in two rows, distant about three inches; the distance of the impressions in each row being three or four inches, and the individual impressions about one inch in length. They seem to have been made by the points of the toes, which must have been armed with strong



AMPHIBIAN FOOTPRINTS, DISCOVERED BY LOGAN AT HORTON BLUFF, NOVA SCOTIA. (1.) One-fourth natural size; (1*a*.) natural size.

Dawson—" Air-breathers of the Coal-Period."

and apparently blunt claws, and appear as if either the surface had been somewhat firm, or as if the body of the animal had been partly water-borne. In one place only is there a distinct mark of the whole foot, as if the animal had exerted an unusual pressure in turning or stopping suddenly. One pair of feet, the fore-feet, I presume, appear to have had four claws; the other pair may have had three or four, and it is to be observed that the outer toe, as in the larger footprints discovered

by Dr King, projects in the manner of a thumb, as in the cheirotherian tracks of the Trias."

At last Logan reached Pictou. We say at last, for it was a long, tedious drive there from Windsor, by way of Halifax. Expecting to sail from the latter port for Britain on the 4th. of October, there was only a week left in which to see the Pictou coal-field. But anyone who has seen him work when pressed for time, will have an idea of how he worked on this occasion, pacing from dawn till dark across the measures, searching under every coal-seam for an underclay, and everywhere finding it. Nominally he stayed at "Mount Rundle," with Mr. Poole, Superintendent of the Albion Mines, who showed him every possible attention; but if night overtook him in his wanderings, he craved a lodging at the first farm-house to which he came. "One day," he tells us in his journal, "I measured away for about two miles up the East River, and when it was dark called in at the nearest house, which I found to be that of a farmer of the name of McNaughton. I asked him several questions about the limestone in the neighbourhood, and was about to enquire where I could get quarters, when Mrs. McNaughton said that of course I could not think of going farther that night, and that she would supply me with supper and bed, such as they had. To this I readily agreed. They were at tea in another room, to which we adjourned, and I had my tea. The family consisted of a son grown up to man's estate, and three daughters in regular gradation of age below the son. They were all very kind, and seemed to make me

welcome. At table there was a shoemaker, who was staying in the house for a few days to renovate their pedal integuments.

"After tea, 'Bring me the book,' said the father of the flock. So the book was brought, and forthwith he read a hymn, first the whole and then two lines, which were sung, and so on. Then he read a chapter in the Bible, and then we all knelt down, and he gave us a prayer of which I could not understand two successive words. It was given with a strong Highland accent and drawl, and the utterance of each word was so slow and so long that I forgot the sound of the beginning before the end came. This lasted about twenty minutes, and after it we began to talk. I produced a map of the country, and asked many questions about limestone and copper, for which a trial was made in the neighbourhood some years ago. The map was accurate, and seemed to please wonderfully. My feet were a little wet, and Mrs. McNaughton offered to supply me with a pair of dry stockings. To this I assented very readily, and then we all adjourned to the kitchen fire. Here a huge log was blazing, and small sticks were heaped on the dog-irons. My stockings were hung up to dry, and one of the daughters set about making bread for the morrow. . . . The son, who had been down to the mines, produced a newspaper, and one of the daughters read it aloud. The first thing she fell upon was a case of breach of promise of marriage, the perusal of which produced a great deal of merriment. The reason the gentleman gave to justify his desertion of the lady was that she pro-

nounced rise *ris*, that she had tickled his sister, slapped her, &c., &c.

"When it approached 10 o'clock, I began to give signs of being a little fatigued, I fancy; for the good woman told me the bed was ready. But she said she supposed I would have no objection to the *other gentleman* occupying a part of it. The other gentleman was nobody less than the shoemaker. What could I say? I said nothing, and went to bed with my flannels on, and kept as near the edge of the wall side of the bed as I could. I soon fell asleep, and never knew when the shoemaker took to his repose. The intimation of his having done so at all was at daylight, when he awakened me by getting up. I got up soon after him, and after breakfasting on bread and milk, bade Mr. and Mrs. McNaughton good morning, and set about the continuation of my section."

When Logan reached Halifax he wrote to his brother James as follows: "I have been to Pictou, where I have thoroughly examined the district about the Albion Mines. I now know what the ground contains for about a mile deep in that neighbourhood, and in every case where I have seen a seam of coal it is accompanied by one of underclay, filled with *Stigmaria ficoides*. My fact, therefore, I now consider established beyond controversy.

"The deposit of coal at the Albion Mines does not equal that of Pennsylvania at Mauch Chunk, but it is a magnificent one, notwithstanding. There are at least six or seven seams overlying one another, and the largest, which is the one worked, is twenty-four feet

thick in clean coal, independent of bituminous shale, which by many would be considered a part of the seam, and make it twelve feet more."

It was on the occasion of this visit to Pictou that Logan first met Dr. Dawson, who was then beginning his researches in the geology of Nova Scotia, and was delighted at having an opportunity of visiting some parts of the Pictou coal-field in company with so experienced a worker.

CHAPTER VIII.

THE ORIGIN OF A SURVEY.

FOR years before the establishment of the Canadian Geological Survey its need had been realized by many of the more intelligent people of the country. A few papers on local Canadian geology had, it is true, been published, and important collections of minerals made by Dr. Holmes of Montreal, Dr. Wilson of Perth, and others; but no extended systematic work had been carried on, and almost nothing was known of the relative age of the various formations and of their distribution.*

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* Among the papers on Canadian Geology published previous to the establishment of the Geological Survey may be mentioned the following:—

Notes on the Geography and Geology of Lake Huron. By Dr. Bigsby, F. L. S., M. G. S. Trans. Geol. Soc., Ser. II., Vol. I., p. 175. (Read in 1823).

Notes on the Geology of the North Coast of the St. Lawrence. By Capt. Bayfield, R. N. Trans. Geol. Soc., Ser. II., Vol. V., p. 89. (Read Nov. 20th., 1833).

On the Geology of Lake Superior. By Capt. Bayfield, R. N. Trans. Lit. & Hist. Soc. of Quebec, Vol. I., p. 1.

The first person to move in the matter of a geological survey seems to have been Dr. Rae. As early as January, 1832, a petition from this gentleman, praying for pecuniary assistance to prosecute a geological and statistical survey of the Province, was sent down to the House of Assembly by Sir John Colborne, at that time Lieutenant-Governor of Upper Canada. But notwithstanding its being accompanied by a favourable recommendation from the Lieutenant-Governor, it was not so

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On some of the Rocks and Minerals of Upper Canada. By Capt. Bonnycastle, R. N. Ibid., p. 62.

On the Geology of a Portion of the Labrador Coast. By Lieut. Baddeley, R. E. Ibid., p. 71.

Remarks on the District traversed by the St. Maurice Expedition in the Summer of 1829. By Lieut. Ingall, 15th Regt. Ibid., Vol. II., p. 7.

Notes on the Country in the Neighbourhood of Montmorency. By William Green. Ibid., p. 181.

Additional Notes on the Geognosy of St. Paul's Bay. By Lieut. Baddeley, R. E. Ibid., Vol. II., 1831, p. 76.

An Essay on the Localities of Metallic Minerals in the Canadas, with some Notices of their Geological Associations and Situation, &c. By the same. Ibid., Vol. II., p. 332.

On the Magdalen Islands. By the same. Ibid., Vol. III., p. 128.

A Geological Sketch of the most South-eastern Portion of Lower Canada. By the same. Ibid., Vol. III., p. 271.

Notes upon the Country in the Vicinity of Quebec. By H. D. Sewell, M. A. Ibid., Vol. III., p. 298.

A Sketch of the Geology of the Island of Montreal. By Dr. Bigsby, F. L. S., &c. Annals Lyc. of Nat. Hist., N. Y., 1826.

On the Transition Rocks of the Cataraqui. By Capt. R. H. Bonnycastle, R. E. Am. Jour. Sci., Ser. I., Vol. XVIII., 1830, p. 85, and Vol. XX., 1831, p. 74.

Mineralogical Examination of the Sulphate of Strontian, from Kingston (U.C.), with Miscellaneous Notices of the Geology of the Vicinity. By Lieut. Baddeley, R. E. Am. Jour. Sci., Ser. I., Vol. XVIII., 1830, p. 104.

Concerning several of the above-named writers, Sir William, who was always very particular about acknowledging information derived from the

much as considered by the Committee of Supply, to which it had been referred.

In December of the same year, the York Literary and Philosophical Society presented a petition praying for a grant of money to provide for an investigation of the geology, mineralogy, and natural history of the Province. But this shared the fate of its predecessor, although it, too, served to draw attention to the matter. No further action seems to have been taken until 1836, when, on the motion of Mr. W. L. Mackenzie, seconded by Mr. Durand, Messrs. R. G. Dunlop, Gibson, and C. Duncombe were named a Committee to consider and report on a plan for a geological survey of the Province. The report was printed, but again was not considered. Nothing daunted, however, Mr. Dunlop gave notice in the following November of a motion for leave to bring in a Bill for the purpose of instituting a geological examination of the Province. The Bill was not proceeded with, but later in the some month, on motion of the last-named gentlemen. seconded by Col Prince, the

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labours of others, afterwards wrote in the preface to the *Geology of Canada*, 1863, as follows:—

"Admiral Bayfield has communicated to the Literary and Historical Society of Quebec, and to the Geological Society of London, various interesting papers on subjects connected with Canadian geology, with the facts in which it will be found that we have on several occasions availed ourselves.

"Among the pioneers in Canadian geology, no observer was more accurate than Dr. J. J. Bigsby, Secretary to the Boundary Commissioners under the Treaty of Ghent. His range of investigation extended from Quebec to Lake Superior, and beyond the limits of the Province in that direction; and he has accumulated and published a great store of facts, upon the exactness of which the greatest reliance can be placed.

"Lieutenant, now Major-General Baddeley, of the Royal Engineers, when in Canada, now nearly forty years since, was an ardent promoter of

House went into a Committee of the Whole to consider the expediency of a geological survey. On the report of the Committee it was resolved that an address should be presented to His Excellency the Lieutenant-Governor, Sir F. B. Head, with reference to the practicability of the desired survey; but for some unexplained reason the address was never presented.

Again, in December, 1836, Mr. Dunlop, with characteristic pertinacity, gave notice of an address to the King for a grant of wild lands to defray the expense of a geological survey; but again the address failed to be presented. Here the matter dropped, not to be revived until after the union of the Provinces, during the administration of Lord Sydenham, a man who fully appreciated the importance of ascertaining the nature and extent of the mineral resources of Canada.

The first united Parliament met in 1841, and in the month of July the Natural History Society of Montreal, through Mr. Benjamin Holmes, and the Literary and Historical Society of Quebec, through Mr. Henry Black,

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geological enquiry, and his services were made available to the Provincial Government in explorations in the region of the Saguenay, and in the peninsula of Gaspé. To him we are indebted for the first published notice of the Lower Silurian limestones on Lake St. John, Bay St. Paul, and Murray Bay, as well as of the existence of gold in the drift of the Eastern Townships. Lieut. F. L. Ingall was another explorer, who about that time did good mineralogical service on government expeditions; the district to which his attention was directed being the country between the St. Maurice and the Ottawa. Captain R. H. Bonnycastle, R. E., at a somewhat later period, interested himself in the examination of various mineralogical and geological phenomena, more particularly in the neighbourhood of Kingston, where his military duties had placed him. The results of his observations were given in Silliman's Journal in 1831, and in other publications, and have been cited in this Report."

petitioned for aid to carry out a geological survey. The result was that the matter was taken up by the Government, and on the motion of the Hon. S. B. Harrison, the sum of £1,500 sterling, for the purposes of a survey, was included in the estimates.

But it was not for Lord Sydenham to carry into effect the wishes of, or even to prorogue the Parliament which he had summoned. On the 5th. of September, while riding near Kingston, the town which he had selected as the capital of United Canada, he was thrown from his horse, and so seriously injured that he died on the 19th. of the same month. In January, 1842, he was succeeded by Sir Charles Bagot, upon whom devolved the appointment of a Provincial geologist. Logan, as we have seen, was in England at the time; but his friends in Montreal, knowing his desire to obtain the position, took occasion to place his name before the Governor. Sir Charles, however, referred the matter to Lord Stanley, then Secretary of State for the Colonies, and the result was that His Lordship, on recommendation of De la Beche, Murchison, Sedgwick, and Buckland, offered the position to Logan in the spring of 1842. In reply to the enquiries concerning his qualifications, addressed to these distinguished geologists from the Colonial Office in London, the following letters were received by the Under Secretary, Mr. G. W. Hope, M. P.:—

"ORDNANCE GEOLOGICAL SURVEY OF GREAT BRITAIN,
"4*th. April*, 1842.

"SIR,—I have the honour to acknowledge the receipt of your communication of the 2nd. instant, accompany-

ing the copy of a letter to Lord Stanley from His Excellency the Governor-General of Canada, on the subject of the qualifications of Mr. W. E. Logan to undertake the geological examination of Canada, for which the Provincial Legislature has voted the sum of £1,500.

"I would request you to do me the favour to represent to Lord Stanley that I consider Mr. W. E. Logan perfectly qualified for the task, having had occasion, during the progress of the Ordnance Geological Survey in South Wales, to examine the labours of that gentleman upon the important coal district contained in large portions of Glamorganshire, Carmarthenshire, and Brecknockshire.

"Prior to the appearance of the Geological Survey in that part of the country, Mr. W. E. Logan had carefully investigated it, and at the meeting of the British Association for the Advancement of Science, held at Liverpool, in 1837, he exhibited a beautifully-executed map of it.

"The work on this district being of an order so greatly superior to that usual with geologists, and corresponding in the minuteness and accuracy of its detail with the maps and sections executed by the Ordnance Geological Survey, we felt desirous of availing ourselves of it, when Mr. Logan most handsomely placed it at our disposal. Having verified this work with great care, we find it so excellent that we shall adopt it for that part of the country to which it relates, considering it but fair and proper that Mr. Logan should obtain that credit to which his labours so justly entitle him.

"His sections are all levelled and measured carefully, with proper instruments, and his maps are executed

with a precision only as yet employed, except in his case, on the Ordnance Geological Survey; it being considered essential on that Survey, for the right progress of geology and its applications to the useful purposes of life, that this accuracy and precision should be attained.

"Personally, I have examined several portions of country with Mr. W. E. Logan, and can safely affirm that no one can be more careful, able, or desirous of attaining the truth.

"He has made communications to the Geological Society respecting points of high interest connected with the formation of coal, and recently has communicated to the same Society a memoir on Nova Scotia and Pennsylvania, important in various respects, more particularly as relating to Canada.

"I would further observe that Mr. Logan is highly qualified as a miner and metallurgist to point out the applications of geology to the useful purposes of life, an object of the highest importance in a country like Canada, the mineral wealth of which is now so little known.

"I should anticipate the best results, both to the science of geology and its applications, from the employment of Mr. Logan on the Geological Survey of Canada.—I have, &c.,

"H. T. De la Beche,
"*Director Geological Survey.*"

"16 Belgrave Square, 3*rd. April,* 1842.

"Sir,—In reply to the letter of yesterday, which you did me the honour of addressing to me by the desire of Lord Stanley, and in which my opinion is asked respecting the capability of Mr. W. E. Logan to under-

take a geological survey of Canada, I have great pleasure in saying that I consider him to be eminently qualified to execute the task.

"I beg to state that I recommend Mr. Logan not merely from my acquaintance with his works in general, but also from a knowledge of certain very skilful labours in the South Wales coal-field, which drew from me a strong expression of my sense of their value in an account of the map of the Silurian region.

"I would add that, having chiefly studied the older rocks, including the carboniferous deposits, Mr. Logan is admirably prepared to develop the structure of the sub-soil of Canada, which consists in a great measure of such strata; and I venture to assure Lord Stanley that if his Lordship should approve of the suggestion of Sir Charles Bagot, he will render essential service to that important colony, and materially advance geological inquiry.—I have, &c.,

"ROD. I. MURCHISON."

"CAMBRIDGE, *5th. April*, 1842.

"SIR,—I take the earliest opportunity of replying to your letter of March 31st., containing a copy of a despatch from Sir Charles Bagot on the subject of a geological survey of Canada. Of Mr. Logan I personally know very little; but I know his character, and something of his labours. He is an excellent field-geologist, as he has proved by his admirable map and sections in South Wales; and he has extended his observations into the coal-fields of the United States, having, as I am informed, read an excellent paper on the coal-fields of Pennsylvania. I had not, however, the good fortune

to be present when this paper was lately read at a meeting of the Geological Society. I have no hesitation in recommending Mr. Logan, and I have no doubt that, if appointed to the Survey of Canada, he will enter on the labour with unbounded zeal and with very great skill.—I have, &c.,

"A. SEDGWICK."

"OXFORD, *2nd. April,* 1842.

"SIR,—My absence from Oxford has prevented me from receiving until this day your letter of the 31st. March, asking my opinion as to the qualifications of Mr. W. E. Logan for undertaking a geological survey of Canada.

"I beg in reply to state that I was recently on the point of writing to Sir Charles Bagot for the purpose of recommending him as pre-eminently qualified for this service, but I withheld my application, because I considered that his services might with still greater advantage to this country, be applied to a survey of Nova Scotia, where there is a large and very valuable coal-field belonging to the Crown, with which he is better acquainted than any man living, and respecting which, and also the coal-field of Pennsylvania, he read a most valuable paper ten days ago, before the Geological Society of London.

"About a fortnight ago I wrote a letter to Sir Robert Peel, requesting his attention to the expediency of employing Mr. Logan to make a geological survey of Nova Scotia. Should Sir Robert have forwarded this letter to Lord Stanley, I beg to refer to it in evidence of my opinion of Mr. Logan, and his high qualifications,

as the most skilful geological surveyor of a coal-field I have ever known.

"Mr. De la Beche has adopted *in toto* for his geological survey of the Ordnance Map of Wales the work he found completed by Mr. Logan as to that part of the South Wales coal-field which is near Swansea, and I will procure from Mr. De la Beche to-morrow a statement of his opinion as to Mr. Logan's work done in Glamorganshire, which I will take the liberty of submitting to you.—I have, &c.,

"W. BUCKLAND."

On the 22nd. of June while Sir Charles Bagot was on a visit to Montreal, he was waited on by a deputation from the Natural History Society, who presented him with an address requesting him to become the Society's patron. After His Excellency's reply to the address, he entered into conversation with the members of the deputation, and took occasion to remark that "he had recently been called upon to appoint a geologist for the Province. The selection he had made —that of Mr. Logan—he was sure would give as much gratification to the Society as it had to himself. Previous to his appointment of Mr. Logan, he had considered it proper to refer to England for an account of his qualifications, and the result was that a mass of testimonials was sent out . . . affording ample testimony that to no one could the important office be more appropriately entrusted than to that gentleman."

Sir Charles Bagot also communicated to one of the members of the deputation the following letter with reference to Mr. Logan, which had been addressed by

the learned geologist, Dr. Buckland, to the Bishop of Oxford :—

"CHRIST CHURCH, 23*rd. April*, 1842.

"MY DEAR LORD,—I have recently sent to Sir Robert Peel and Lord Stanley two official certificates, stating my opinion of the high qualifications of Mr. Wm. Edmond Logan, F. G. S., to execute a geological survey of Canada. I am further anxious, and feel it a duty I owe to the public service, to submit, through your Lordship, to Sir Charles Bagot, a few points relating to this gentleman, which I could not mention in a public document.

"His talents as an accurate mineral surveyor are of a very high order, and are known to the scientific world by his description of portions of the great coal-fields of Glamorganshire and Pennsylvania, illustrated by most accurate and valuable maps and sections, constructed by himself, which he has laid before the Geological Society of London. Moreover, he is not only enthusiastically devoted to and highly qualified for field-work in geology, but he is also a man of modest and gentlemanly demeanour, and of high principle, and good conduct and right feeling, with whom it is pleasing to have intercourse, and in whom it is quite safe for persons in authority to place confidence.

"Believe me, my dear Lord, very faithfully and truly yours,

"WILLIAM BUCKLAND."

Logan's appointment having been confirmed, he arrived in Canada late in the month of August, and at once reported himself at Kingston, the seat of Government. Here he spent several weeks awaiting

instructions, and at the same time "culling facts from the members and casting about for maps." Writing to his brother James, on the 19th. of September, he says: "Rawson* informed me on Saturday that the political storm which had been blowing rendered it impossible to attend to my affairs. I told him that in that case I should make an excursion, and give time for the ground-swell, which might continue a few days longer, to settle into quiet water." An excursion was accordingly made to Marmora, to see the iron mines of that region, and another to Brockville, "to ascertain the spread of the Silurian limestone." A visit was also paid to Dr. Wilson of Perth, a physician "who had collected a good deal of information with respect to the country in which he resided." Having finally escaped from Kingston, he spent several weeks in making a geological examination of different parts of the Province, and in adding to his knowledge of its topography. He also prepared a "Preliminary Report" for the Government, giving a concise statement of the general views which he had then formed of the geology of the country. For this work no charge whatever was made to the Government.

In the month of December, with the Governor-General's permission, he returned to England, in order to fulfil professional and other engagements during the winter. His father had died at Clarkstone in 1841,†

* Rawson W. Rawson, Esq., at that time Civil Secretary to the Governor-General of Canada.

† Mr. William Logan died either on the 14th. or 15th. of June, 1841, and was buried on the 19th., in Polmont Churchyard. His wife died several years before.

and no doubt there was much to be attended to in connection with the settlement of his affairs. Before his death he had signified his willingness to have Clarkstone remain in the possession of the family; but the members were now so scattered that this was found impracticable, and the estate was sold.

Sir Henry de la Beche was for years one of Logan's warmest friends, and did all in his power to encourage and assist him in his geological work. Just before Logan's departure for Canada he sent him the following letter:—

"LLANDOVERY, 31*st. July*, 1842.

"MY DEAR LOGAN,—Herewith I send two letters to Rawson. The one open is nothing but the usual sort of affair, to be presented by yourself; the other, *sealed*, is the right thing, and you must take care to have it sent to him by post, or otherwise, as you may think right, *before* the other is presented, so that he may know all about matters before he sees you. Mind this. If you send the sealed note by post, pray pay the post thereof

"In my note in answer to yours, and sent to Swansea, I said the best and safest way would be to leave the maps and sections* with Mr. Trenham Reeks (our Secretary at the Museum of Economic Geology), to be kept with other Ordnance matters he has in charge for me.

"Now, my dear Logan, as I want to do you every justice, had you not better give me some account of the coal-beds themselves, which I can quote as yours, or at

* Referring to Logan's maps and sections of the Glamorganshire coal-field.

any rate let me have the information which I can give as from you. *Suum cuique* is a motto that I like, and you must have the full credit for what you have done.

"Now, mind you, if you think I can be of any use to you in the Canadian Survey, don't scruple to say so, as I am fully in earnest, and no mistake. There may be odds and ends of things which can be usefully done by us, and so you must consider us as a kind of colleagues, all working for the same end, and that the cause of truth

"But not to get prosy, mind and use me when you like in this survey, and the more you do so the more I shall like it.* Wishing you all health and happiness, believe me ever yours,

"H. T. De la Beche."

The survey upon which Logan had embarked in Canada was characterized by Sedgwick as a "Herculean task." No one, however, understood the difficulties better than did Logan himself. At the same time he was full of enthusiasm and had no hesitation in undertaking the work. He saw in Canada a most tempting field for original research, and felt, no doubt, that the greater the difficulties the grander would be the conquests. The spirit with which he began the work

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* In a letter written from Swansea to his brother James, in March, 1842, Logan says: "De la Beche has informed me that if I get the Canada Survey he will assist me in all difficulties, with all the scientific force of the Geological Survey of this country, either in the way of chemical analysis or the determination of new fossils; and that he will arrange so that a certain quantity of specimens may come here free of expense by every packet, and be returned, after examination, in the same way."

is shown in the following semi-official letter to Sir Henry De la Beche:—

"LONDON, *24th. April,* 1843.

"MY DEAR SIR,—You are aware that I have been appointed by the Provincial Government of Canada to make a geological survey of that colony. The extent and nature of the territory will render the task a most laborious one; but I am fully prepared to spare no exertion of which I am capable, to render the work, when it is completed, satisfactory to those who have instituted the examination, and creditable to myself. I am especially anxious to bring the investigation to a conclusion in as short a time as a due regard to geological truth and the applications of the science will permit; and in considering a systematic plan of operations to be adopted for the attainment of so important an object, I naturally feel desirous of bringing to my aid the experience of one who, from the position he has occupied for many years past as Director of the Ordnance Geological Survey of Great Britain, is more fitted than any other person to advise me on all practical points, whether with regard to the work to be done in the field or to the general machinery of the Survey. And it appears to me that not only your advice as to a plan of operations, but your positive assistance in the work of the Canadian Survey, might be made available, and this with advantage to the investigation which you yourself conduct in Britain.

"No one knows better than yourself how difficult it would be for one person to work with effect in all the branches of so extensive a subject. To carry out the

field-work with vigour, to reduce all the sections with the requisite degree of accuracy and map the geographical distribution of the rocks, to collect minerals and fossils, and to analyze the one, and by laborious and extensive comparisons to determine the geological age of the other, is quite impossible without a proper division of labour. But it is in the palæontological department of the investigations that it seems to me the British and Canadian Surveys might be made mutually serviceable. In Canada, all the expensive means of palæontological comparison have yet to be brought together. There is no arranged collection of fossils, and no such thing as a geological library to refer to.

"The correct determination of fossils in the country is, therefore, at present, quite out of the question. Now, in the British Survey, the examination of organic remains is made the work of a distinct department, and has been confided to an able naturalist, whose great acquirements and extensive means of reference, if brought to bear on Canadian fossils, would not only ensure accuracy and save time, but benefit his own generalization on Britain, by widening the sphere of his comparison.

'Many interesting facts connected with the geographical distribution of particular fossil genera and species might thus be ascertained, the confusion arising from a want of unity in nomenclature be avoided, and Canada become the measure of a correct geological comparison between the continents of Europe and America.

"From the fact that the Survey has been urged by the Legislature of the country, it is natural to infer that a

great desire is felt by the enlightened part of the Canadian community to be made acquainted with the leading geological features of the Province; but the main object of the investigation is, no doubt, to determine the mineral riches of the colony, and it is not unlikely that a wish may be felt by its inhabitants to know the result or the probabilities of the survey long before it can possibly be completed. To meet such a desire in those States of the American Union in which geological surveys have been undertaken, resort has been had to a system of annual reports. The example thus given may by some be considered to afford the best mode of making known the progress of the work; but the system appears to me objectionable for many reasons, and as the consideration of it has no doubt come before you among the various subjects connected with the Survey of Britain, I should be obliged if you would give me the expression of your opinion regarding it."

In answer to this communication, De la Beche, tne very next day, addressed the following letter to Logan, which will be read with interest by many connected with Geological Surveys at the present time:—

"LONDON, 25*th. April,* 1843.

"MY DEAR SIR,—In reply to your communication of the 24th., I have no hesitation in stating my firm belief that important benefits would arise, as regards the effective progress of your labours in Canada, saving both time and expenditure, if some arrangements could be made by which a kind of union could be effected between the Geological Surveys of Canada and of Great

Britain; an object which, judging from the tenor of your letter, you seem desirous to promote.

"Placed, as you will be, in Canada, unassisted by easy access to the opinions and co-operating labours of those scientific men whose different researches are so essential to the right understanding of the results obtained from the geological surveys of large areas, it seems to me quite necessary for the full development of your labours that some plan should be adopted, by which, while you investigate in the field the geological structure of the country, the great groundwork of all, you should receive the assistance of the ablest men our country can produce in the important accessory branches of knowledge—in fact, that the results of your labours should be such as to do credit to the Government under whose auspices the survey is conducted.

"Without a proper division of labour, and the power to avail ourselves of the co-operating researches of the most competent men in the accessory branches of knowledge above noted, with the facility of consulting valuable museums and libraries, the advance of the Geological Survey of Great Britain would never have been such as it now is. And it forcibly strikes me that if the Government could so arrange that you might avail yourself of the sources of information which we have organized, not only would time and money be saved, but the importance also of your investigations would be increased, inasmuch as the subjects of Canadian and British geology might be treated together, under the same system, with mutual benefit to both and to the progress of science.

"How useless, or rather worse than useless, would it be for you to incur the heavy expense of figuring organic remains common to Canada and the British Islands, while in connection with the Geological Survey of Great Britain we are, under the authority of the Treasury, preparing a fit and proper national work on fossils. Even if for any report you required such figures, could it not be readily arranged that we furnish impressions of the plates to you? Besides, it is most important for the right progress of this department of science that as much as possible the same kinds of fossils from different parts of the British possessions should be examined, described, and figured by the most competent naturalists.

"With respect to the publication of annual reports of geological surveys, they can scarcely be but very unsatisfactory documents, and for the most part very undigested records of real progress. How is it possible to come to accurate conclusions before all the facts to be considered are known? Concise reports to Government, in general terms, of the progress made are essential, showing that the time has been properly occupied. Such statements are made annually by the Ordnance Geological Survey, when the yearly estimates are under consideration; but such documents are very different from published statements containing views that in the end may not be sustained. Neither in France nor in other European States where geological surveys connected with their Governments have been or are in progress, have such reports been given to the public, though separate

memoirs on *well-ascertained* points have sometimes appeared.

"Crude annual reports may even be detrimental to the true progress of science, as it may readily happen that an author, having once committed himself to a hasty view or opinion, may feel great reluctance to withdraw it, and thus somewhat distort additional facts that militate against it; so that the clear conclusions to be drawn from the facts eventually obtained are not by any means so apparent as they should be.

"Let me, in conclusion, assure you that any aid that we may fortunately be able to afford on our Survey to yours in Canada is entirely at your service, and that we shall consider it a duty, as well as pleasure, to assist in any way that may be considered useful.—Very faithfully yours,

"H. T. De la Beche."

The question of a geological assistant had been discussed by Logan when in Kingston in 1842, and on the strength of De la Beche's recommendation, he was subsequently authorized to secure the services of Mr. Alexander Murray, a young man who had originally been educated at the Royal Naval College, Portsmouth, and had served for some years in the Navy; but who, at the time of which we write, was devoting himself to geology, and working enthusiastically as a volunteer on the Ordnance Survey under De la Beche. From 1837 to 1841 he had lived in Canada, and had served as a volunteer during the rebellion there. His first personal intercourse with Mr. Logan was in London during the winter of 1841-42; but in the succeeding spring he

went to Swansea, and accompanied him in many of his geological excursions in the surrounding country.

Referring to this time, Mr. Murray afterwards wrote:—"Even at that early period, when every comfort of life was easily accessible, I observed his utter indifference to self-indulgence of any kind, or even such ordinary comforts as most people would be inclined to call indispensable necessities. After an early and very simple breakfast, he would buckle on his instruments, grasp his hammer, and with map in hand, march off to the field, in which he would toil on without cessation, without thinking for a moment of food or rest, until the shades of evening gave warning that it was time to retrace his steps towards home, or to seek some temporary dwelling."

Mr. Murray (now a C. M. G.) was connected with the Geological Survey of Canada for many years, but was afterwards appointed Director of the Survey of Newfoundland, a position which he still holds. Throughout he has been a zealous and daring explorer, and to the last Sir William regarded him with feelings of the warmest friendship.

CHAPTER IX.

GASPÉ EXPLORATIONS, 1843.

IN the spring of 1843, Logan again crossed the Atlantic, to enter systematically upon his new duties in Canada. In his journal, he pathetically refers to the fact of his being sea-sick for the first time, although it was his eighth voyage. Reaching Halifax on the 30th. of May, he determined to journey overland through Nova Scotia and New Brunswick, to his destination in Gaspé, visiting on the way that wonderful display of the coal-measures at the South Joggins, on the Bay of Fundy, a knowledge of which he felt might be of service to him in studying the geological formations of Canada. At the South Joggins he spent several weeks, and it was at this time that he executed his great section of the coal-measures, which, as has been truly said, is "a remarkable monument of his industry and powers of observation." It gives details of nearly the whole formation of the region, or 14,570 feet, including seventy-six beds of coal and ninety distinct Stigmaria underclays. Nowhere else in the world is

there so magnificent, or so instructive an exposure of the coal-measures as that of the Joggins. Imagine a thickness of three miles of strata, tilted up so that almost every successive bed is brought to view! What a history is there contained! This great series consists of marine and fresh-water deposits, in which no repetition of beds can be detected, and in which there are no faults to mislead one in estimating the thickness.*

Hastening on to New Brunswick, Logan devoted a short time to the examination of about fifty miles of coast on the south side of the Baie des Chaleurs, and then went on to Canada, reaching Gaspé early in July. Gaspé was deemed a most important part of the country for examination; for coal had long been reported to exist there, and it appeared by no means improbable that at least patches of the Carboniferous might be found. From Gaspé he sent an official announcement of his arrival to the Governor-General's Secretary, Mr. Rawson W. Rawson, and also the following private letter:—

"GASPÉ, 10*th. July*, 1843.

"MY DEAR SIR,—I have visited the Joggins, on the Bay of Fundy, and I never before saw such a magnificent section as is there displayed. The rocks along the coast are laid bare for thirty miles, and every stratum can be touched and examined in nearly the whole distance. A considerable portion has a high angle of inclination, and the geological thickness thus

* Logan's section of the coal-measures at the South Joggins was published in 1845 as an appendix to his first "Report of Progress" to the Canadian Government, and occupies no less than sixty pages.

brought to view is very great. I measured and registered every bed occurring in a horizontal distance of ten miles, taking the angle of dip all the way along. Of course there has not yet been time to put together the facts thus collected; but when this is done, I shall be able to tell you every foot of what is in the crust of the earth in that part of it, for at least three miles deep. The whole deposit belongs to the Carboniferous era, and in one part of the section a multitude of coal-seams are exhibited. Mr. Lyell has stated them at nineteen, but they much exceed that. There is one thing, however, that Lyell has not mentioned, which is that the commercial value of this display does not by any means equal its geological beauty. Of all the coal-seams exposed, I am sorry to say not more than two, or at most three, are sufficiently thick to be worked beneficially.

"In my examination of the neighbourhood of Bathurst, I saw only two coal-seams, but neither of them sufficiently thick to be profitably worked. One of them is six inches, and the other eight to ten inches.

"From all I hear, and something I see, it appears probable that the Carboniferous rocks do extend into Canada, but it is very problematical whether the Canadian part of the deposit will be productive. In this part of Canada there is a very favourable exposure of the rocks along the shores of the Gulf of St. Lawrence, and the various bays connected with it; and for the purpose of ascertaining the order of their superposition with accuracy, it is my intention to proceed around the coast with a canoe and an Indian to carry my instru-

ments. Boating is too expensive, and not so independent a means of travel, and there are few roads of which to avail myself. I have with me, at my own charges, a young man of the name of Stevens, from Bathurst, a son of Mr. Stevens who established the Gloucester Mining Company, in New Brunswick. Knowing something of mineral exploration, having a dash of the necessary enthusiasm, and being accustomed to rough it in the woods, able to handle an axe, manage a canoe, and fit up a *camp*, as they call it, I anticipate with his assistance, and that of the Indian, getting along with economy and despatch. The nature and geological thickness of the formations that constitute the country once determined, the examination of their geographical distribution will be much facilitated. The chief difficulties connected with it will then be those of a physical nature in penetrating the woods.

"It is probable that to a geologist this part of Canada will present a great many more interesting features than the western division of the Province. It appears to differ considerably from what has been observed by the American geologists on the south side of the great lakes, in the State of New York. Disturbing forces have fractured the rocks, and thrown them into mountains and valleys. The country, therefore, abounds in picturesque scenery, in this respect far surpassing Western Canada; but for that very reason, in addition to its more northern latitude, it cannot be so fine a country for agricultural settlement. . . ."

Of the topography of the Gaspé district little was known in 1843 beyond the coast line; of the geology,

practically nothing. Settlements were few, confined almost exclusively to the coast, and made up chiefly of fishermen. There were no roads through the interior, most of which was (and indeed still is) a wilderness, inhabited by bears and other wild beasts, or at best, only penetrated in certain seasons of the year by a few Indians or lumbermen. The courses of most of the streams were unknown, and the precipitous mountain passes untraversed. Such was the country whose geology Logan was now to investigate. It certainly needed courage to enter single-handed upon such a work. But from first to last he never complained. Beetling cliffs were scaled, rugged mountains climbed, rapid rivers traced to their source; and all with that calm determination and fixity of purpose by which he was ever characterized. No coal, it is true, was found in Gaspé, but its absence was demonstrated conclusively. Many important geological facts were accumulated, and a large amount of topographical work accomplished, the value of which has since been fully recognized.

In the summer of 1843, Mr. Murrey was at work in the Upper Province, examining the country between Lakes Huron and Erie, and Logan's only companions were the Mr. Stevens whom he had brought with him from Bathurst, and his faithful Indian, John Basque. Beginning with the towering cliffs of Cape Rosier, the coast was examined all the way round to Paspebiac, on the Baie des Chaleurs, a distance of about 100 miles. Logan's measurements were made by pacing along the shore, while his Indian followed with the birch canoe,

and occasionally ferried him over places too deep to wade, or round projecting cliffs. When evening came they camped, or perhaps sought the shelter of a fisherman's hut or an Indian wigwam. The measurements of the day were plotted, the journal written up, often with no better light than that of the glaring camp-fire; and then, thoroughly tired with combined physical and mental activity, Logan slipped into his blanket sack, stretched himself upon a bed of spruce-boughs, and slept the sleep which he so much needed. Before retiring to the recesses of his sack on the evening of July 13th., 1843, he made the following entry in his journal: "It is very dark, and our fire brightens up its face. Our pork for to-morrow boils away right busily. The woods are becoming as silent as the grave; not a breath of wind is stirring. The faint stroke of the axe against a tree tells us that others are camping, probably within half a mile, and the monotonous gurgling of the river will perhaps lull them to slumber as well as us. Basque is on his knees, and though his back is towards me, I can see from the crosses he makes that he is saying his prayers. So it is time to prepare for bed."

Logan's Gaspé journals, if published in full, would make quite a stout volume, but they describe scenes with which almost everyone is now familiar, and would, if given *in extenso*, be tedious to the reader. Like the note-books containing his field-measurements and geological observations, they are illustrated by pen-and-ink sketches, which often exhibit more than ordinary skill. The following extracts from the Journal of 1843 will, we think, be read with interest and

amusement. They are tinged with their writer's quiet humour, and serve to show how little escaped his notice, even in the way of the most trivial things and circumstances. John Basque's summer residence, for example, is described with as minute detail as if it were a profoundly interesting geological phenomenon:—

"*Sunday*, 16*th*. *July*.—Basque's wigwam is about fourteen feet square. The sides and ends are constructed of unplained boards, placed edgewise on one another for about three feet up, and kept together by stakes on each side at the corners. There is a space left for the door in one of the ends. Upon these boards peeled pine poles are placed in a sloping position for rafters. They rise up to the height of about eight feet in the centre, where they are supported by two poles that run from end to end. On the rafters is laid a quantity of spruce bark, making a roof. The bark lies across the pole lengthwise, and one piece overlaps another, tile-fashion, while sticks and boards, with one end on the ground, are made to rest upon the bark to keep it in its place. One gable end is constructed in the same manner, but the other is made of boards, one end of which rests on the horizontal boards of the walls. A piece of coarse canvas, with several holes in it, hung on pegs, constitutes a curtain for the door—a very convenient one for dogs and cats to make their exits and entrances by. But a board placed edgewise for a lintel debars the pigs from the same privileges.

"In the centre of the floor is placed a cracked stove, about three feet long, two wide, and two high, from which rises a pipe passing through the roof, left open

for the purpose, and for the sake of light. The stove rests on three iron legs, and one a compound of stone and wood. Around the stove is left a space of about two feet, and between this and the wooden walls, on all sides but that of the door, is a space covered with a carpet of fir boughs, confined at the outer edge by three poles stapled with willow down to the earth. This carpet is about four feet wide, and forms a sitting place by day, and a sleeping place by night. In one corner is an unplained board for a dresser, its ends supported by means of the same material. Pails and tubs occupy the space below, cups and dishes that above. Three or four trunks occupy the corners.

"Two dogs, two cats, two Indians (Basque and his brother), two squaws, two children, two strangers (Stevens and myself), occupied this apartment last night, with a rousing fire in the stove in the middle of July. I crept into my blanket sack, without dispossessing myself of my nether integuments; yet I did not find it uncomfortably warm. This is Basque's summer residence, and it has not been thought necessary to stop the chinks. The night air, therefore, comes in on all sides, and towards morning, even in July, the air is a little cool about three or four o'clock. . . .

"We had a severe thunderstorm in the morning, and another, still more severe, in the afternoon. Two or three claps put me in mind of the Montreal thunder, when I was at school. The landscape from the door while the storm was gathering was beautiful beyond description. The dark clouds spread over the distant mountains, giving them as deep a blue as ever Robson

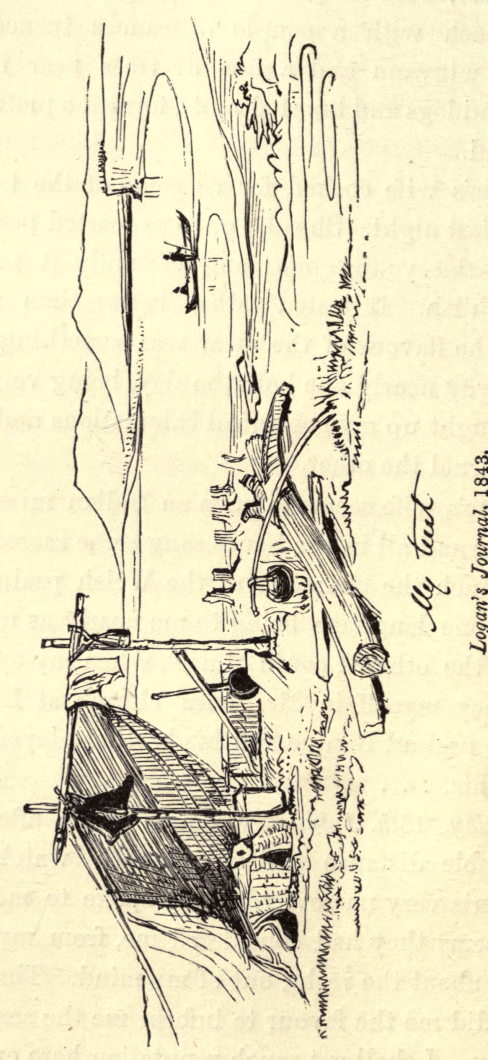
put on paper. In the middle distance was the expanse of the river, with its pine-wood margin; while a low, sandy beach with a couple of canoes turned over, Basque's wigwam and a few fir trees near it, with stumps and logs and knotted roots, formed a picturesque foreground.

"Basque's wife cooked for us some of the trout we obtained last night. She also gave us roasted porcupine, choosing the young one; and certainly it made an excellent dish. It tasted rather better than sucking pig, but the flavour of the meat was something like it. I slept away nearly one half the day, being very tired; and I brought up my geological calculations and a little of my journal the other.

"Basque's wife seems to have an Indian missal, from which she and all in the house sang some sacred music. It had much the character of the Welsh psalm tunes, and the one language being to me nearly as unintelligible as the other, I could almost, when my eyes were shut, fancy myself in Mr. Jones' church at Kilgarrin. After the psalms, Basque and his brother played a game of draughts. . . .

"*Tuesday*, 18*th. July*.—Two men came after me a considerable distance to-day, evidently watching my movements very narrowly. They spoke to me at last, and it seems they had considered me, from my various gambols about the rocks, out of my mind. Three clam-diggers did me the favour to inform me the same thing yesterday. I shall get much reputation here evidently.

"The weather was so stormy to-day that the canoe could not proceed along shore. Stevens and Basque



Logan's Journal, 1843.

remained behind to camp at the neck of the peninsula, while I proceeded down about three miles to Cape James, and returned by the shore as I had gone. The tide was flowing on my return, and I had to wade round the projecting capes, wetting myself to a point considerably above my knees. Twice I scaled the cliff. I was in a nice state when I got to the tent, but made myself very comfortable by changing even to my flannels. . . .

"*Thursday*, 20*th. July.*—To-day we have come round to Little Gaspé, which is a regular fishing-station. Fishing-stages and drying-houses occupy a high, pebbly beach, which, on the upper part, is dotted with stacks of dried codfish, covered with birch-bark, weighted to keep it down. In the bay is a whaling schooner at anchor, and fishing-boats in numbers keep it in countenance. On the left a long limestone point projects away to the south-east, and completely shields the bay by its height on that side. On the right is a projecting horn of sandstone, and Douglas and the Highlands are seen beyond.

"Our tent is pitched on the beach, and there is nothing between us and the pebbles beneath but a few fir-tree boughs. We are where fishermen most do congregate. Already we have had several levees, and I fear we shall find them rather troublesome. Our piscatory friends have, however, given us some mackerel for supper, and I have bought three large lobsters for threepence, one of which is changing his colour in the pot. We are beginning to have rain, and I fear it is to be a wet night. . . .

"*Tuesday*, 25*th. July.*—William Prevost's tempering of steel is not so good as I expected. The chisels are too hard, and will not stand at all, and the point of my hammer has already broken. I have had a hard day's work. No quarryman ever worked harder. I began at 6 a.m., and did not leave off until seven in the evening. I have, however, collected a good many fossils from the limestone close by, but not enough to determine its age.

"As Stevens and I were hammering away, one of the fishermen came along to the rock, evidently with the intention of being a looker-on at our operations, and making his remarks upon our work. I was not desirous of being troubled, so I resolved to get rid of him without delay. When he came up to the place he stopped his walk, and I stopped my hammering, and sat on the specimens I was disengaging. 'You are working away,' said he. 'You are *not*,' said I. 'I think we shall have more wind,' said he. 'I do not pay much attention to the wind,' said I. So he stood and said nothing for a little while, and I sat and looked at him. He then continued on his walk, as if he had come that way on other business. But before he had proceeded thirty yards, he was brought up by the cliff and the tide, and being obliged to return the way he had come, looked as if conscious I must know he had come our way through mere curiosity. All these fishermen fancy that I must be getting something worth much money, considering the pains I take. Nothing less than a silver mine answers their notions. One of the fishermen has sent me a piece of halibut for breakfast to-morrow. The

northern lights are very bright, indicating, as Basque says, a change of weather. . . .

"*Friday*, 28*th. July.*—The day is clear and bright and warm, and we are on our voyage to Indian Cove. The water is so quiet and so clear that we plainly see the bottom in four fathoms. The fish swim lazily below, as if enjoying the weather as well as we. . . . Grey limestone cliffs, crowned with pine trees, are on my left, while on my right the craggy mountains of Isle Percée are seen some twenty miles off. . . . Two other canoes are upon the water, with Indians going to Cape Rosier. They look very picturesque.

"A Jew who came to the neighbourhood to trade the other day, hailed my canoe just now, or rather beckoned to us (for we were out of hearing), just as we had passed Grande Grêve. I fancying he might have geological information to give me, hastened nearer the shore. When we were closer, I asked him what he wanted. He put his hand to his mouth, trumpet fashion, and bawled out, 'Have you any beaver skins?' He took us all for Indians. I put my hand to my mouth, and roared out, 'I have no skin but my own, and that I am unwilling to part with.'

"A breeze is springing up right in our teeth, though we have not yet got farther than St. George's Cove. But here we shall deposit two boxes of specimens, and lighten our canoe a little.

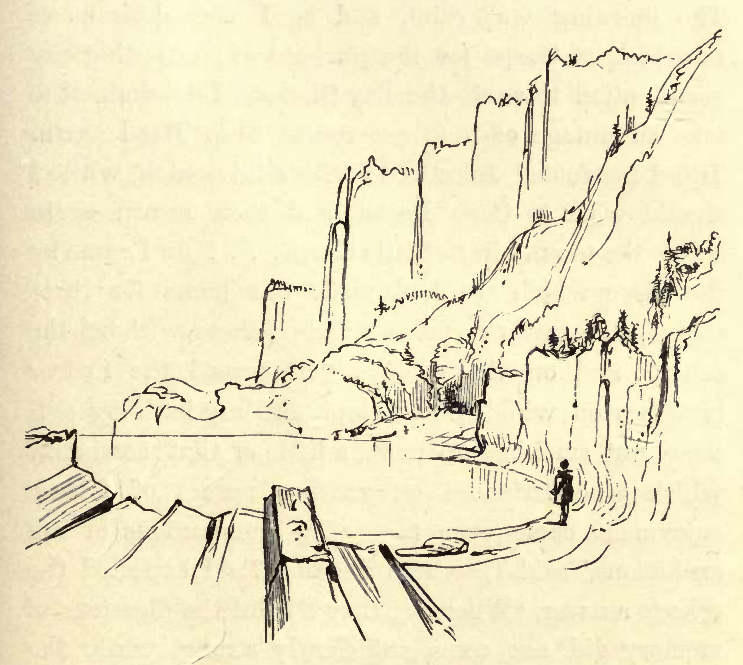
"By the time we got to Indian Cove quite a strong breeze was blowing, and the water had become very rough. . . . As usual when the fishermen returned from their day's work, they all flocked around my tent,

to the number of about a dozen, to wonder at our instruments and whole equipage. I usually beg my fresh fish of them in return. . . .

"*Monday*, 31*st*. *July*.—This morning early we struck our tent, determined to come round Cape Gaspé in our canoe, the weather being remarkably calm, and it being my intention to examine the coast in this direction as far as Cape Rosier. The least breath of wind would have rendered the attempt quite impossible, for the broad water of the Gulf of St. Lawrence strikes full against the rocks of the point, which rise up from the sea to the height of 700 feet, perpendicular as a wall, or in many places with the summit overhanging the base. They presented the grandest scene I have ever beheld. Gulls and gannets were flying midway from the water, and yet they appeared as small as pigeons. We saw some teal swimming on the water between us and the shore, and resolved to get a shot at them. We considered them to be very young, in fact unable to fly; but the four we obtained turned out to be full grown. The height of the cliff had deceived us. It makes everything look small that is near it. . . .

"We are camped in a most beautiful little cove at Cape Bon Ami, surrounded by the most romantic and magnificent scenery. There is just one house near, and French-Canadians live in it. They have a capital little garden, with the first flowers I have seen in this part of the world, in addition to abundance of cabbages and potatoes. Like everybody in this region, they are fishing people; and though there is a drying-house in the cove, they do not work in it at present. They preserve their

fish round the Cape Bon Ami, in another cove, about a quarter of a mile off. We are thus relieved from the abominable stench of decaying codfish-offal and putrid whale-blubber, which have been offending my nostrils



LITTLE BON AMI COVE, SHOWING CLIFFS OF THE GASPÉ LIMESTONE, 700 FEET HIGH.

Logan's Journal, 1843.

ever since I came to Gaspé. When we last camped at Indian Cove, two barrels of putrid blubber, from which the oil was straining, stood within two yards of us, and when a gust of wind came from them, I thought I should become ill. . . .

"*Thursday*, 10*th. August.*—At Little Gaspé again. We have had rather a busy day. We were up at four, and had breakfast as soon as possible. Then my three boxes were carried to one of the fish-sheds near, to be forwarded to St. George's Cove for the steamer. . . . The morning was calm, and as I was desirous of returning to Gaspé for the purpose of continuing my examination towards the Bay Chaleur, I determined to take advantage of it to get round Ship Head again. This I instructed John to do with all despatch, while I should walk to Cape Rosier, and then return again across the mountain to Little Gaspé. . . . As I came by the place which we had made our home for three nights, and saw the poles sticking there without the canvas, and on the pebbles still spread the fir-tree branches on which I had slept, and my back-log still there, but smoking no more, a little of that merriment which is experienced on visiting scenes of former enjoyment came over me. 'The companions of my excursions,' said I, 'where are they?' I expected the echo to answer, 'Where are they?' But the pleasures of memory did not come sufficiently strong, while the smell of stinking fish came too strong, and the echo, like a true Irish echo, only seemed to say, 'Gone to Little Gaspé.' So I started to join them. A very romantic walk I had over the pass called the Portage, of which I had already finished a sketch from memory. . . .

"I reached Little Gaspé about two o'clock, where I found my canoe and companions, and a kettleful of pea-soup. . . . On our arrival here [Gaspé], we found that a great frigate had come into the port lately, and as we

sailed past, we looked very small I fear, proud as we felt of our exploits of the day. It is not often that a canoe has come from Cape Rosier to Gaspé in the few hours mine has, doubling a great and usually stormy cape like that of Ship Head, and making good her way over rough water for thirty miles. . . . I have taken lodgings with Mr. Paddy, as he is called, though his name is McCannah, and have given John permission to go to see his family. . . .

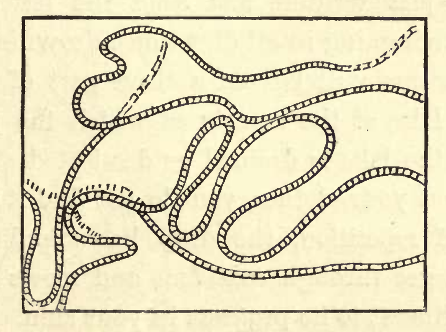
"*Friday*, 11*th. August.*—I feel myself much refreshed by my sleep of last night. It is certainly a great comfort to get rid of all ligatures when one goes to bed, and to have soft feathers below one, instead of hard pebbles—even though one be a geologist. . . . I am off on an excursion up the south-west arm of the river to a spring said to be of *coal tar*, which all the people here consider a sure indication of coal. It may be petroleum, but I do not expect to find coal with it.

"Here we are, camped in the woods on the south-west arm, and to-morrow we visit the Silver Brook, on which the tar spring is. We have dined on three trout, which John speared as we came along. To-night we are to go out trout-spearing by torch-light, to provide our breakfast for to-morrow morning. John has prepared birch-bark flambeaux, which consist of strips of the bark, to the number of a dozen, about two feet long and four inches wide, and tied up by strings of cedar root. The flambeau is split up into small strips at one extremity, for the purpose of easy ignition. We are only waiting for the dark

"I do not know what we should do in the woods without birch-bark. It is certainly one of the most useful things an Indian can boast of. He makes his canoe of it. He uses it for roofing his house. He makes of it vessels to carry his maple sugar and his gum, and twisting it as a chemist does his filter, he makes a cup of it, and it serves him for crockery. Then it is a most inflammable thing, and burns like pitch. He lights his fire by means of it, and catches his fish by its assistance. He does not write on it, because he cannot; but it makes a capital substitute for paper, under either the pencil or the pen, and to save paper I have been using it for my rough calculations. . .

"*Friday*, 18*th. August.*— . . . It is 12 o'clock at night, and I am fagged. I have just put into ink my observations of the day, which has required four hours; and before that I had been hard at work measuring, and noting, and cracking stones for specimens, from six o'clock in the morning. I have had a blow on the head from a great stone weighing half a hundredweight, which fell upon me, fortunately from no great height. It has bruised my temporal muscle on the left side, and I can masticate only with great difficulty. John brought us soup about four in the afternoon. If he had brought anything that required the use of the jaws, I must have gone without dinner. I have had a tumble, too, on a slippery stone, striking my elbow; and I put my foot between two stones and pinched my instep, so that I am all bruises, and my limbs are as stiff as sticks. I'll go to bed.

"*Sunday, 20th. August.*—We got our specimens of annelids yesterday. It rained a little during the morning, but became fine in the afternoon, and was very calm all day—a beautiful canoe day. The canoe, however, was too narrow a vessel for one of the specimens, which measured five feet one way and four feet eight the other. We were obliged to borrow a flat from the fishermen to get it home to our tent. It weighs about three hundredweight. It would have been a pity to break it up, as the full effect of the worm-tracks cannot



SUPPOSED WORM-TRACKS FROM GASPÉ SANDSTONE.
About one-twelfth natural size.

be appreciated from a small specimen. I also got some fossil shells from the same bed as the annelids; only two species, however, and by no means very distinct. I begin to think these are not true coal-measures, notwithstanding that I have seen a small seam of coal, two inches thick. The plants are not Carboniferous. . . . The rain is coming down harder and harder. The wind is beginning to blow, the sea to break heavily on the shore, and our tent to leak. I have been lying in the tent conducting the drops which soak

11

through the canvas down to the edge or bottom of the sheet. When the rain soaks through it runs down the inside of the canvas a little way, until it meets a dry place. This produces an impediment to the current; a large drop immediately collects, and down it falls. To a disinterested person it would be very amusing, no doubt, to witness the inconvenience caused by these drops. While you write one of them will probably fall just at the point of your pen, take all the ink out of it, and spread it on the paper; or one will fall on what you have just written, and send the letters of the alphabet swimming in all directions, drowning a word or two; or one will fall on a clean part of the page, forming a lake, at the margin of which the pen must stop until the lake is drained or dessicated. If any of them fall on your clothes, you do not find it out until, by dint of repetition, the drop has supplied water enough to get through coat, &c., and meets with the first impediment to its progress in your skin. You then discover that capillary attraction has made a morass of a considerable space around the centre of supply, and if the spot happens to be one not conveniently exposed to the fire, your science is considerably perplexed to find a remedy for the evil. . . .

"*Saturday, 2nd. September.*— . . . We have got to Percé, and have taken up our quarters at Mr. Moriarty's. Percé is quite a town, and there is very picturesque scenery about it. I must remain here two or three days.

"*Sunday, 3rd. September.*— . . . The town of Percé, as it may be called, is situated on a point of land, which

juts pretty far out into the Gulf of St. Lawrence. It is surrounded by bold rocks and romantic mountains; but there are no roads to conduct you among them, so that you may enjoy the scenery. The houses are separated into two groups by a rocky point called Mont Joli, in front of which, and sometimes approachable on foot, when the ebb of spring tide gives the opportunity, is what is called the 'split rock,' or l'Isle Percée. It is so named from the fact of the sea having worn two holes through the island, which look like two mighty doors in a great cathedral. The highest point of the split rock is 299 feet above high-water mark, as ascertained with line and plummet by Mr. Moriarty, with whom I lodge. The breadth of the rock on top is about 200 feet, and its length is eleven acres. Its form is something like the letter S. It is very difficult of access, and no one has ascended since a foolhardy fellow, named Pierre L'Egle, took it into his head to dance upon a projecting piece of rock, which gave way under his feet, and dashed him to atoms on the beach. This was about six years ago. Up to that time Mr. Moriarty had always cut hay on the top; but the magistrates have now interdicted anyone from going up

"On the north side of Percé Point are the rocks which I surveyed while occupying the corner of the beach in Malbay, and one of which shows a perpendicular face of 666 feet. . . . On the outside of the split rock there is an island about a mile in diameter, called Bonaventure. The side next the mainland is pretty well occupied by fishermen's houses and fishing-stages. It has a moderate slope, and a pebbly beach; but the

outside of the island is very bold and rocky. The precipices, I understand, are some of them 500 feet in height, and the water is many fathoms deep at their base, rendering it quite impossible to walk along. I shall, therefore, have to go round the island in a canoe.

"*Tuesday*, 5*th. September*.—After breakfast this morning, I had again to put my barometer in order. The mercury had leaked a good deal. After doing so, I set out with Stevens and a son of Mr. Moriarty's to ascend Mount Anne. There is a grand view from the summit, and the island of Miscou, on the other side of the Baie des Chaleurs, is visible on the horizon. Percé and its shores appear to be quite at our feet, and the split rock looks of no height at all. The mountain has a perpendicular face to the southward, and looks over the shore which extends between White Head and Cape d'Espoir.

"The day was warm and the sun shone out brightly. I collected materials to determine the height of a considerable number of points on the ascent. The whole of the hill is composed of the unconformable conglomerate. We returned from our excursion in time to enable me to continue my measurements along shore, and the tide being at the lowest point of ebb when I came to the point of Mont Joli, I had an opportunity of walking over dryshod to the split rock, and getting a few fossils there. Its perpendicular face, 300 feet high, looks very grand when one stands at the base.

"*Wednesday*, 6*th. September*.—The day being fine, I took advantage of it to make the tour of Bonaventure Island, which lies opposite to Percé, and is distant

about a couple of miles. Mr. Moriarty lent me his whale-boat for the purpose, and in addition to Stevens and Basque, I had two other men in the boat, one an old fellow of the name of Fournier, who was well acquainted with every part of the island.

"We had a sail for our boat; but the wind was not fair for making the island. So the oars were used. As we approached the island, Fournier pointed out to me a huge block which had fallen from the cliff, to which the name of *la cruche* is given. Another is called *la pierre carrée;* another, *le mouton.* These are on the north-west side of the island, and the cliffs are there bold, being about 300 feet high. Having made the island, the wind favoured us a little, and we ran down the west side, which is rather low, though rocky. The same may be said of the south side, the cliffs not being more than fifty feet. But as we came to the eastern side, the boldness rose to grandeur, and there are several places where the perpendicular height cannot be much short of 600 feet. In these cliffs are two ledges, which are distinguished by the names of the South Gannet Ledge and the North Gannet Ledge, from the circumstance of their being the resort of myriads of these birds, which build their nests in the crevices of the rocks. The ledges were actually whitened by them, and having no less than three guns and a rifle with us, we loaded to procure some of the gannets as specimens. A thousand of them sat in a row, double and treble deep, on a ledge which projected slightly from the face of the cliff and there they remained, in spite of our presence.

"I took my aim at one, with shot No. 4, and fired; but I seemed to produce no effect upon the bird, beyond causing him to quit the ledge and fly away seaward. I tried another, and another, and another, and half a dozen besides, with the same effect, and then made up my mind that they were too high up, though they did not appear to me to be distant more than 100 feet. Hundreds upon hundreds of the birds were flying about by this time, some leaving, some lighting on the ledge, and I determined to wait for a chance of one on the wing, when it should approach within good range. One soon did so, and down he came with a tremendous crash on the rock. I then left the sitting birds, and stuck to those on the wing, killing four or five. John and Stevens, and one of the men in the boat, killed some more, and we got altogether eleven of them. . . . Though the young ones have not yet begun to fly, they are full-fledged. But they are so fat that they cannot rise on the wing. They are as large as the old ones, but their plumage is quite different. The old ones are white all over the body and wings, with the exception of the tips of the pinions, which are quite black. . . . The length of the gannet, from the tail to the beak, is is about two and a half feet, and from tip to tip, when the wings are spread, about four feet. They are very fierce when wounded. One of them, shot before we got ashore on the ledge, turned upon the boat open-mouthed, and bit at the pole with which Basque was endeavouring to hit it on the head.

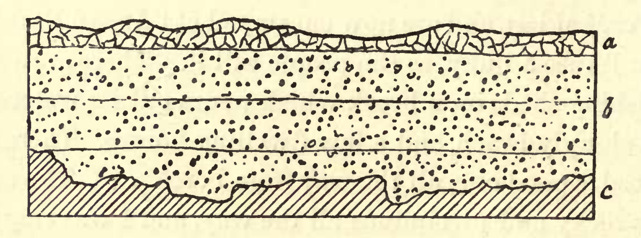
"Going along after our work of slaughter was over, we saw several places where the water had worn

away the base of the cliff, and eaten out great caverns in it. Two of them are called *la grande fourne* and *la petite fourne.* The summit overhangs the base in some places as much as thirty yards. The rock consists of the same conglomerate as that which forms Point St. Peter, and also the summit of Mount Anne, and which is unconformable with the older rocks beneath. We returned from our excursion about four o'clock, and I had time to go on with my examination round Mont Joli and Battery Point. . . .

" *Tuesday,* 12*th. September.*—We have got away from Percé at last, and are now encamped at l'Anse à Beaufils, or l'Anse à Buffy, as the people call it. There are a few fishing-sheds on a brook which pours out its waters on a shingly beach, and a few dwelling-houses. There is a road, a good one, all the way from Percé. . . . The coast is rocky and precipitous all the way, and I was stopped by the tide about half a mile from our resting-place. . . .

" *Thursday,* 14*th. September.*— . . . We have pitched our tent at Little River Cove, on the beach, and I believe all the inhabitants of the Cove have been to visit us, one after another. There are twenty-three families settled here. The number of fishing-boats is twenty-five. While occupied in examining the rocks on the other side of the brook, a multitude of the fishermen flocked round me, curious to know what I was about. One of them asked me if I was searching for buried money, and if the instruments I used indicated the proximity of hidden treasure. I explained the use of the instruments to him, and he seemed much gratified by it. . . .

"*Friday*, 15*th. September.*—We were up at daylight, and got away from our last night's position just as the the sun was rising. I have walked all the way along the beach, a distance of six miles, to Grand River, the canoe accompanying me, and taking on board the specimens I collected. The most interesting feature of the day has been a trap floor overlying the horizontal conglomerate, and the appearance at the same time of the highly-inclined rocks which the conglomerate overlies unconformably.

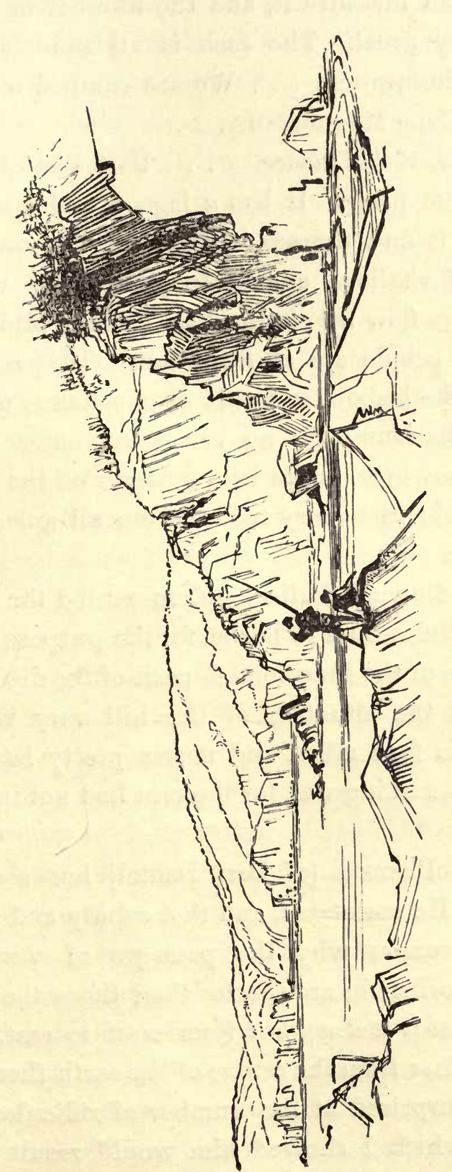


SECTION NEAR MOUTH OF GRAND RIVER, GASPÉ.

a. Trap. *b.* Bonaventure conglomerate. *c.* Tilted Upper Silurian limestones.

"Now we are camped in a wood on the bank of the Grand River, which seems to pour out a large quantity of water. A bar runs across the mouth of the river, and makes behind it a harbour in which schooners of fifty tons can float. There are two or three fathoms of water in the channel through the bar.

"*Tuesday*, 26*th. September.*—We were up by sunrise. I started to my work on foot before the canoe was ready, and I certainly have had the hardest work that the Survey has yet brought me. The coast is so abominably ragged, that it is with the greatest diffi-



SKETCH AT CAPE MAQUEREAU, NEAR JUNCTION OF LOWER AND UPPER SILURIAN.

Note Book, 1843.

culty I can measure it, and the number of sights has been very great. The rock is all sandstone of the hardest description. . . . We are camped on the very point of Cape Maquereau. . . .

"*Friday*, 13*th. October*.— . . . Port Daniel is a very picturesque place. It has a lagoon and a sand-beach between it and the sea, with a narrow outlet. The lagoon is shallow, and is frequented by wild fowl. Two rivers flow into it, the East and the Middle River. . . . The people are all fishermen. They secure their boats in the lagoon, and this circumstance gives it an air of a harbour; but no vessel can enter. The bay outside, however, is the best harbour on the coast, and vessels ride in it very secure from all gales except a south one.

"After dinner I dialled and measured the high road as far as Ruisseau à la Barbe, for the purpose of tracing the course of the limestone deposit of the district, and I made out the situation of the hill very well. The distance is four miles, and it was pretty late when I returned—soaking wet, for the rain had not intermitted all day.

"Mr. McPherson [of Port Daniel] has some queer notions. He maintains, and that calmly and seriously, that the reason why the passages of vessels from America to Britain are shorter than those the contrary way, is that it is *down hill* from west to east, America being further from the centre of the earth than Europe. He was surprised at the number of ridiculous consequences which I showed him would result if such a doctrine were correct. . . .

"*Saturday*, 14*th. October.*—It still rains. This is the sixth day of easterly wind and rain. It is doing much harm in this part of the country. I have been up the Middle River about three miles, to one of the spots where Mr. Williams saw indications of a coal-field. . . . I saw an abundance of black shale; but why that should be an indication of coal, I cannot tell. I believe there is no coal, and that the rock does not belong to the Carboniferous era, but underlies the limestone, which, by its fossils, is declared to be older than the coal. This is a disappointment. But I must look at this place again in the spring. There is too great a freshet in the river just now to permit a proper examination. Port Daniel having been advertised as a coal-field, I must be cautious before I contradict the report. . . .

"*Tuesday*, 17*th. October.*— . . . This part of the country is pretty well settled. The houses look comfortable. The land is flat, being on the unconformable conglomerate, which comes in about three miles to the eastward. It is said to continue all the way along the coast for twenty to thirty miles. If so, that part of the coast will be easily examined. . . . I have had a long walk along the shore to the point where I met the conglomerate yesterday in my morning's overland excursion. As I proceeded along the cliffs, I found many of the inhabitants busy securing their potatoes. Some stared at me with much curiosity, and some expressed a desire to know what I was about. In one field where there were about eight young people at work, men and women from seventeen to twenty years

of age, they all, as I took a sight with my compass, drew near, and forming a semi-circle around me, all stood and stared, just as I have seen so many cows and oxen gather round anything very strange to their vision. I took my sight, and then turning to them said, 'Well?' 'Where do you come from?' said one of the boys. 'Ah!' said I; 'Where do you come from?—where are you going?—what are you doing?—what's your age?—where were you born?—and what's your name?' 'Yes,' said one of the boys. So I laughed, and walked off without satisfying their curiosity.

"I had not gone half a mile further when an old man came puffing after me from another field. He scrambled over several fences to catch me, but did not gain ground. At last he called out to me across a field, 'I say! Hallo, I say! Mr., I say!' I turned round, and sang out, 'Well, what do you say?' 'I want to speak to you.' I thought he might have heard I was surveying the country for the Government, so I turned back, and coming up to the fence where he stood, leaned over on one side, while he leaned over on the other. So we stared at one another for a few seconds. He was an elderly man, with grey hair, and dressed in a blue jacket and trousers, with a glazed hat. 'Well,' said I. 'Where do you come from?' said he. I could not help laughing. 'Where do you come from?—where are you going?—what are you doing?—what's your age?—where were you born?—what's your name?' said I. 'Well, well!' said the man, 'we are out of the way of hearing news, and when we see a stranger among us we are always curious to know

what circumstance has brought about his visit.' 'Why then I will inform you.' So I told him what I was about, and that I came from Montreal. 'I have been there,' said the man; 'I have been at Michillimackinac, in the service of the North-West Company.' So he gave me his story, and we had a talk about the rocks in the neighbourhood. Subsequently, twenty other men followed me; but they only watched, and said nothing. . . .

"I have been as far as two miles eastward round the cape called Loup Marin. The unconformable conglomerate forms the upper part of the cliff the whole way; but as far as the point the lower part is occupied occasionally by the tilted limestone, with fossils similar to those of Port Daniel. I was under the necessity of measuring part of my distance by the road, the sea coming up deep against the base of the cliff. Proceeding along the road a considerable distance, it became necessary to measure a line to the shore again, to determine a point there. As I paced across a field for the purpose, counting my steps as I went, I heard footsteps coming behind me. At length, when I arrived at rather a boggy spot, a voice at my heels exclaimed, 'I say, sir, this is not the road!' I went on counting my steps, and to keep the number in my mind, I counted aloud: '110, 111, 112, &c.' 'I say, sir, this is not the road!' again exclaimed the voice. '117, 118—it's my road—119, 120, &c.,' said I. 'It's a wet place, sir!' '123, 124—it does not require a Solomon to tell me that —125, 126, &c.' 'You'll get wet, sir!' '128, 129— don't bother me—130, 131, &c.' Here a young man went by me, and kept right in front of me to impede

my progress. This made me somewhat angry, and coming up to the stump of a tree which would do for a mark, I freely gave him a piece of my mind for interrupting me in my occupations. He seemed rather startled, and stared at me as if he thought I certainly must be mad. On I went again in my count, walking in a straight line through and over all impediments. . . .

"*Wednesday*, 18*th. October.*— . . . Here we are at Paspebiac, and here I suspect is at an end my examination of this part of Canada, for the present. . . . When I came this way in July, I brought a letter of introduction to Mr. Hartley, the Manager of the fishing establishment, from Mr. Deblois of Bathurst, and to him we presented ourselves again. He invited us to take up our quarters in the dwelling-house of the establishment, which we have done. . . . I have made arrangements to cross the bay over to the New Brunswick side, for the purpose of getting to Pictou by Bathurst and Miramichi, from which last place there is a steamer that goes every Monday to Pictou, by way of Prince Edward Island. At Pictou, I shall take the 'Unicorn' steamer for Quebec. This is safer than returning to Gaspé Bay. Sometimes the steamer does not, because it cannot, put into St. George's Cove—that is, when either fog or strong wind prevails—and I should feel myself in a very unpleasant predicament should I be caught there by such an accident. . . .

"*Thursday*, 25*th. October.*—At Pictou, at last. I left Miramichi by the steamer 'St. George' yesterday morning, about eleven o'clock. . . . We reached Charlottetown, the capital of Prince Edward Island to-day,

about twelve o'clock, and stayed there nearly an hour. I went ashore, and was much pleased with the wide streets and neat buildings of the town. There seemed much business doing in potatoes and vegetables of all kinds.

" *Wednesday*, 31*st. October.*—At length the 'Unicorn' has made her appearance. If the English mail come forward in its usual time, we shall be off to-morrow. I am very tired of Pictou, for the weather has been bad, and I have been ill. Sunday, Monday, and yesterday, I was confined to the house, and the first two days to my bed, with influenza. . . . The only means of amusement I have had here has been in a few hours spent with my friend, young Mr. Dawson, a very excellent geologist, who has paid attention to the structure of this part of Nova Scotia. He was out with Lyell when he was here, and visited the Shubenacadie with him. He is to make a collection of the fossils of the Silurian rocks in this neighbourhood. I will send him some of our Lower Silurian from Montreal."

When Logan reached Pictou at this time, he was attired in such disreputable habiliments that he looked more like a shipwrecked seaman than a gentleman, and could scarcely be induced to make his appearance outside of his hotel. He was full of the geological information acquired in Gaspé, though disappointed at his inability to gratify the hopes entertained in Canada that coal might be found in the district. He saw in the facts so copiously represented in his note-books the necessity of large researches in palæontology and lithology, and was beginning to consider where he

could obtain the necessary assistance to go on with the work before him. Dawson was then only twenty-three years of age, and had recently returned from the University of Edinburgh, where he had specially studied mineralogy and geology. His engagements in Nova Scotia were of a nature to prevent his leaving the Province, or it is not unlikely he would have thrown in his lot with the Canadian Survey. But this could not be; and though a correspondence was carried on between them, it was not till 1855, on Dr. Dawson's appointment to the Principalship of McGill College, that his personal acquaintance with Logan was renewed. From that time there was the closest intimacy and co-operation, which continued until the death of Sir William, and was unbroken by any want of cordiality. Dr. Dawson, by his investigations of the Post-pliocene deposits, his determinations of the Devonian and Carboniferous plants, and other important investigations, as well as by his influence and advice on many critical points, gratuitously forwarded the scientific objects of the Survey; and Logan, on his part, testified to his appreciation of the scientific work being done in McGill University by his endowment of the Logan Gold Medal and the Logan Chair of Geology.

CHAPTER X.

GASPÉ EXPLORATIONS, 1844.

SHORTLY after reaching Montreal, in the autumn of 1843, Logan proceeded to Kingston, in order to report himself at headquarters, and thence went in search of his assistant, eager to learn the result of his summer's campaign. They met at Toronto, and then came on together to Montreal, where it was decided that Mr. Murray should spend a month or two with his chief before going to his home at Woodstock. During the summer they had collected large quantities of organic remains and minerals, and one of the first questions on their arrival at Montreal was what to do with the specimens. There was no chemist to analyze the minerals, no palæontologist to determine or describe the fossils, no museum in which to display the specimens, not even a room in which to unpack them. But Mr. James Logan came to their aid, and placed at their disposal an "upper chamber" in his warehouse on St. Gabriel Street, where the boxes, papers and other property of the Survey were for the time deposited. The

fossils, of which there were many thousands, were now unpacked, each specimen carefully ticketed with a label indicating the locality, geological formation, &c. The specimens were then repacked in numbered boxes, the contents of which were duly catalogued. Logan, however, was not satisfied with having the originals thus carefully secured, but even constituted himself artist to the Survey, and, in his usual painstaking way, set about figuring some of the most characteristic forms.

On the 11th. of December he wrote to Mr. Rawson: "The collection of specimens the Survey has brought together is quite overwhelming, and when I observe the small impression Murray and I have yet made on our seventy great boxes, most of them requiring at least two men to lift them, I am almost in despair. The fossils alone would be quite occupation enough for a palæontologist for six months. Then there will be our mapping to execute, our sections to reduce, and a report to be prepared on the partial facts ascertained up to this time. . . . It is, however, with regard to the analysis of the minerals that I am most anxious."

Logan well knew that the £1,500 which had been granted for the Survey would scarcely suffice to make a beginning, and was sagacious enough to see that if the Survey was to be continued, he must be able to show that something really practical was being done. It was the loaves and the fishes the people wanted, and few would or could take an interest in the dry details of the sequence and distribution of geological formations, unless they could be persuaded that such mysteries would lead to something utilitarian. So

from the first Logan determined to make a strong point of economic geology. But this, of course, rendered the assistance of a chemist absolutely necessary. He was no chemist himself, and even if he had been, would have had no time to make the required analyses. It happened, however, that a young Pole, De Rottermond by name, had just come to Canada from Paris, where he had been studying chemistry. He was a man of pleasing address, and brought such excellent testimonials, that Logan, after several interviews with him, determined to employ him provisionally, and if possible, to secure his appointment by Government as a regular assistant. With this object in view, and also with the hope of getting some provision made for the continuance of the Survey at the expiration of the original two years, he went to Kingston early in March, and there lost no opportunity of making known his views to the members of Government. From Kingston, he wrote to Mr. Murray as follows:—

"KINGSTON, *7th. March*, 1844.

"DEAR MURRAY,—I have come up to this expiring capital for the purpose of endeavouring to induce the Council to grant me permission to employ Mr. De Rottermond as chemist. But, unfortunately, the day I started from Montreal, Mr. Secretary Daly started from Kingston. We must have crossed half-way, and the result is that I am losing time until his return, which is not expected until next week. . . .

"I have stated to the Governor that I should like to have some more defined arrangement as to the time

the Survey is to be continued. He remarked that it had struck him that the voting of a certain sum without any knowledge as to whether that sum would be sufficient, was a very absurd sort of thing, and that it was but just that a more explicit understanding should be arrived at. I have spoken to Draper on the subject, and think he feels the propriety of putting the Survey on a firmer footing. . . . He has said, however, that unless it can in some way be indicated that value will be returned to the country for the expenditure, it is in vain to expect that the Legislature will support the Survey for the sake of science—in which opinion I thoroughly agree with him.

"In my interview with the Governor, I happened to say that before starting on my explorations in the spring I should, of course, make a report on the partial facts ascertained. He immediately replied that he would place it before the Legislature. . . .

"The object will be to produce an effect on the members. With the same view, I must get a house or a set of rooms for our collection. Managing this, we must put our economic specimens conspicuously forward; and it appears to me that in the exhibition of these, large masses will make a greater impression on the mind than small specimens. A sort of rule of three process seems to go on in the minds of the unlearned when they examine minerals in which they are interested. They are much addicted to judging of the value of the deposit by the bulk of the specimen shown.

"This induces me to say that I should like you to send to Montreal, as soon as it can be done by water

communication in the spring, a thundering piece of gypsum. Let it be as white as possible, and put it in a strong box, similar to those I sent from below. If you come across the lithographic stone, let us have a huge slab of it, six or eight inches thick. . . .

"I hope as you went through Toronto you did not forget the '*Stanniferous-auro-platiniferous Lead!*' You must get that half-barrel from your friend, in order that we may assay a good average sample."

At Kingston it proved impossible to accomplish much; for although on every hand he received assurances of good things to come, no one was willing to take any responsibility in the matter, or sanction the expenditure of the smallest sum of money. Evidently nothing could be expected before the meeting of Parliament, and so, in the meantime, he resolved to act on his own responsibility, and at his own risk. Leaving Kingston, he set out for Albany, where he wished to compare some of his fossils with those of the New York rocks exhibited in the State collection. At Albany he was kindly received by Hall and Emmons of the New York Geological Survey, and every facility was afforded him for making the desired comparisons. Shortly after his return to Montreal, he wrote to the Director of the British Survey:—

"MONTREAL, 20*th. April*, 1844.

"MY DEAR DE LA BECHE,—How is it that you have never written to me? Did you get my letter from Miramichi, and did you get the box of specimens I sent you from Nova Scotia? In my letter I spoke of a section of the Nova Scotia coal-field as displayed at the

Joggins. Since my return from field-work I have reduced all the measurements, and made out a vertical column. It occupies fifty-four pages of foolscap, closely written. The total thickness is 14,570 feet 11 inches. I am getting a written copy of it made for you, but it takes much time. It may be very useful to you in speaking of coal in general in your report. I mean to get the document published somehow or other, and I should be glad if you would allude to it publicly if it illustrates anything you may have to say on South Wales. You will be astonished at the detail in it. You can make a public document of it if you like, by communicating it to the Geological Society. I am aware they would not print it; there is too much detail in it. But were it among their documents, you could then allude to it with more propriety, if you think it worth while. I cannot help thinking it will be considered very instructive in showing the composition of a coal-field. There is not a single apology for coal without an association with *Stigmaria*, even when there are bands of bituminous limestone with the remains of fishes.

"I worked like a slave all summer on the Gulf of St. Lawrence, living the life of a savage, inhabiting an open tent, sleeping on the beach in a blanket sack with my feet to the fire, seldom taking my clothes off, eating salt pork and ship's biscuit, occasionally tormented by mosquitos. I dialled the whole of the coast surveyed, and counted my paces from morning to night for three months. My field-book is a curiosity.

"The coast has an immense quantity of rock exposed, and I met with the same conglomerate which I informed you existed at Bathurst. In Canada, as in New Brunswick, it lies unconformably over the Devonian and Silurian, which undulate beneath. The conglomerate, occasionally becoming a fine red sandstone, always dips towards the coal of New Brunswick, and no doubt must run under it and form the base of the Carboniferous deposits. It rests on the shore of Canada on the margin of the Baie des Chaleurs, but there are no profitable coal-seams or coal-seams of any description visibly associated with it.

"From the Devonian and Silurian rocks I collected no less than seventy boxes of specimens, chiefly fossils, which it took Murray no less than two months to ticket and stuff away into boxes for future examination, when the Government shall give me room to place them in order. I have hired a house on speculation, and am ordering proper cases to hold some of them, in the confident expectation that the expenditure will be sanctioned by the Legislature. But perhaps I may be reckoning without my host, and may be left in the lurch after all.

"I have just returned from a visit to Albany, where I have been studying the New York Geological collection, and I have got together in the way of drawings all that they have done in fossils. Albany is within two days' journey from this, and it will be to me a most useful place to enable me to make comparisons. Until I can contrive to get a comparison instituted with British fossils, I fancy I shall be obliged to

content myself with the American nomenclature. The condition of the rocks of New York, and the certainty with which their order of superposition has been determined, makes that region the key to the geology of a large portion of the North-American continent. In New York, also, there is no want of conformity from the coal to the lowest fossiliferous rocks, and this is the character of the country all the way to the Mississippi, and probably much further west. But a different law prevails to the eastward, in all the country south of the St. Lawrence. The coal is unconformable with the rocks below, and these have suffered violent disturbances prior to the Carboniferous era. . . ."

The house which had been hired to serve temporarily the purposes of museum, office and laboratory, was on Great St. James Street (No. 40), the principal street in the town. The laboratory was equipped, show-cases set up for specimens, and soon the place began to have an orderly and business-like appearance. But spring had come round, and with the spring the time for the renewal of operations in the field. Preparations were made for another season among the rocks of the Gaspé peninsula. This time, however, it was resolved not only to continue the examination of the coast, but to penetrate the wild regions of the interior, and if possible to obtain a section from some point on the St. Lawrence through to the Baie des Chaleurs. Mr. Murray was now to accompany the Director, and also the new chemist, who professed to be an old campaigner, and expressed a strong desire to join the expedition. At Gaspé they were to be joined by

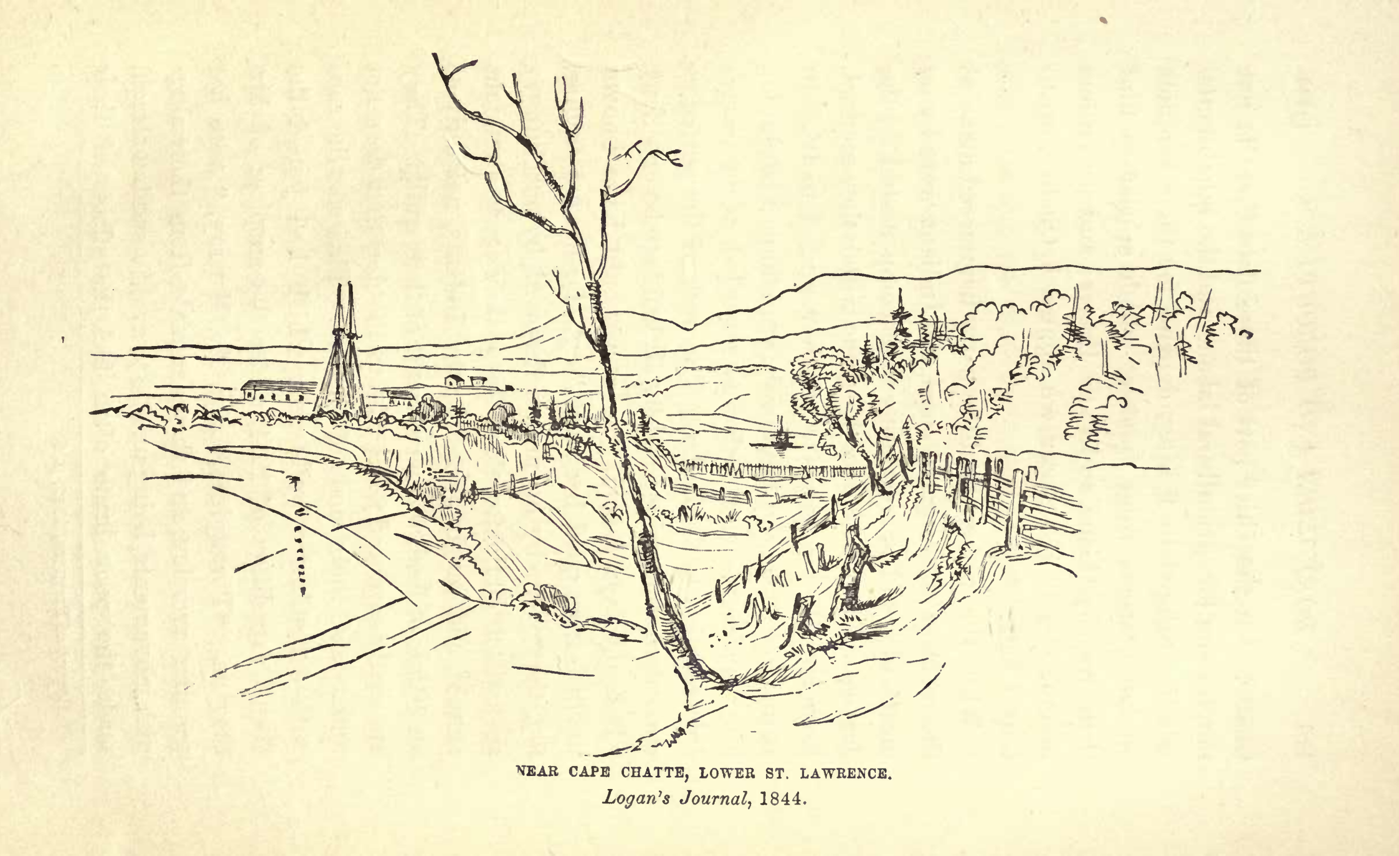
Stevens, Logan's assistant of the previous year, and also by the indispensable Indian, Basque. Leaving Montreal by steamer on the 27th. of May, they reached Gaspé on the 31st., and the arrival was at once chronicled by Logan in his voluminous journal:—

"Here I am again at my old quarters, in the elegant hotel of Mr. and Mrs. Paddy. I hold in remembrance the charge of 2s. 6d. per day for writing in the parlour; so now I indite my journal in the kitchen. . . . My present intention is to return up the St. Lawrence in canoes to Cape Chatte, and then cross over to Baie des Chaleurs, which I expect to strike somewhere near Tracadigash Mountain. We go over St. Anne's Mountain, reported to be the highest land in Canada, its elevation being somewhere about 4,000 feet. As we came down the St. Lawrence in the 'Unicorn,' we saw these mountains, white with snow to the very summit. They looked very formidable. Captain Douglas of the 'Unicorn' has given us a Union Jack to plant on the very highest peak, and as it yet has no name, Murray, Douglas, and De Rottermond propose to call it Ben Logan; but I have expressed my disapprobation, and here enter a memorandum of my protest."

Several days were spent in rating a chronometer, obtaining Indians, canoes, &c., and then the party bade farewell to Gaspé and Mrs. Paddy's "house of entertainment." "Tired of Mrs. Paddy's starving system," says Logan's journal, "we left her on Saturday evening. Poor De Rottermond could stand it no longer. He was fretted out of all patience with the monotony of her *cuisine*. Salmon, salmon, salmon, every day. At

first she told us she could get no salmon; so Murray purchased one from the fishermen, the second day after our arrival. He paid 3s. 1½d. for it, and let Mrs. Paddy have it for the same money. We had part of it at dinner, boiled, and very good it was. The other part Mrs. Paddy put into a little salt, and the salted salmon we had next day, boiled. The third day we had boiled salmon, a little salter; the fourth day the same. As Mrs. Paddy charged 1s. each per meal, De Rottermond was shocked that she should gain so much by the purchase. Then he was shocked at our always having salmon, and again shocked that it should always be boiled. Notwithstanding this, however, we had salmon salter than ever next day, and boiled as usual."

Geological investigations were begun at Cape Rosier, and between that point and Cape Chatte, a distance of about one hundred miles, a careful examination of the rocks was made. "The coast country between Cape Rosier and Cape Chatte is of a mountainous character; the ridges in regular succession run in towards the interior at a very small angle with the trend of the shore, and with the exception of nine miles between the first-mentioned point and l'Anse à Griffon, the hills in general come close upon a rocky and precipitous margin, leaving very little space for settlement beyond the narrow flats at the mouth of the principal streams that descend from the highlands to the St. Lawrence. These are in general occupied by fishing establishments of more or less importance, and among the principal are those of Great and Little Fox Rivers, and those of the Magdalen, the Mont Louis, the Ste. Anne, and the



NEAR CAPE CHATTE, LOWER ST. LAWRENCE.
Logan's Journal, 1844.

Chatte. On the chief part of these flats there is not much room for agricultural labour, and the inhabitants, wholly engaged in fishing, depend for their supplies on importations from Quebec, which appear to find their way by Gaspé and Cape Rosier; and provisions become dearer the closer we approach Quebec, up to Cape Chatte."*

While the geologists of the party hammered away at the rocks of this rugged coast, the Indians were by no means idle, and to a certain extent compensated for the dearness of provisions by the game which they secured. Now and then a porpoise which ventured to take an airing was shot from the canoes, or perhaps a porcupine killed on shore—and each was regarded as an acceptable addition to the larder. The neck of the porpoises was eaten, and pronounced by all hands to be excellent. "Indeed," says Logan, "no one would have known the dish from good beefsteak." As for the porcupines, too, they were by no means despised by our hungry geologists. In the forests of Gaspé they are an abundant animal, and much prized by the Indians, not only as an article of food, but on account of their quills. They are easily captured; but woe to the dog that does not understand their mode of warfare. This was the case with a handsome bull-terrier which had joined the Gaspé expedition of 1844, under the auspices of Mr. Stevens. "Porcupines," says Mr. Murray, "were her peculiar aversion, and these animals, from their sluggish movements, being unable to avoid a sudden attack, made the poor brute often feel the effects of their

* Report of Progress, 1844, p. 6.

invincible armour, which on one occasion would certainly have cost her her life, but for Sir William's kind-hearted sympathy for every mortal thing that could suffer, and his unrivalled patience and perseverance. Unlike the wary Indian cur, which would yelp for an hour to bring assistance, this dog, with the eagerness and undaunted courage of her breed, would attack a porcupine as she would a cat; and on this particular occasion, the porcupine being a large and powerful one, she made a fierce onslaught, grappled with the enemy, in vain attempting to get a hold, until, being discovered, she was carried away, bristling with quills all over the body, the head, mouth and throat. When the poor brute was brought to our camp, her case looked a perfectly hopeless one, and the general opinion appeared to be that if she did not shortly die, it would be only an act of charity to put her out of her sufferings. Not so, however, thought Mr. Logan, who was very fond of the animal, and he immediately volunteered to be her doctor. He got a pair of tweezers, and began what to all appearances was a pretty hopeless operation, but which he succeeded in accomplishing in about two hours' time. Every part of the poor creature was more or less penetrated by the dreadful quills, which every moment were insinuating themselves deeper and deeper by the muscular movement of the body upon the serrated edges. The whole head, even inside the mouth, and as far as could be seen down the throat, was one mass of the formidable appendages. One by one he extracted these, until the head was completely cleared, and then

continued to operate upon the less vital parts, until no vestige of a quill was to be seen on her body. The poor brute was helpless from the effects for many days, but she recovered eventually, and before our campaign terminated, she produced a fine litter of puppies."

Many, indeed, were the incidents which broke in upon the daily routine of the geological work. At one time there was a bear-hunt; at another flambeaux and spears were got ready, and a raid made upon the salmon; but the geology went on apace, and by the 5th. of July they had reached Cape Chatte, where preparations had to be made for the journey inland. As the country on the line of the intended route had never been mapped or examined in any way, it was necessary that they should devote a large share of their time to topographical work, if geological results were to be rendered intelligible. With this in view they began by measuring a base line on the shore, and determined by triangulation the position of a number of well-marked peaks in the ranges of hills to the south. Then, taking to their canoes, they followed the Chatte in its windings as far as navigable, determining its course and length as they went along, by means of prismatic compass and Rochon's micrometer telescope. Then plunging into the dense forests, they slowly found their way to the Cascapedia. But the woods had proved a fitter place for a botanist than a geologist, scarcely any rock exposures having been seen; and as the river seemed likely to afford good sections, it was resolved, if possible, to navigate it to its mouth. Their canoes they had been forced to leave on the

Chatte, and to construct new ones of birch-bark would be too long a process. As for floating down the river on rafts, that would be not only inconvenient, but dangerous. In the emergency one of the Indians suggested that they should build temporary canoes of spruce-bark. Suitable material was obtained with much difficulty, and soon three excellent canoes were ready to launch. In these frail craft the "unknown river" was safely navigated to its mouth, which was reached on the 6th. of September.

During the expedition they were exposed to many privations and discomforts, which early proved more than the chemist could bear, and accordingly he had to be sent back to the coast, to find his way to Montreal as best he could. One of the Indians, too, fell ill with inflammation of the lungs, and would probably have died had Logan not constituted himself surgeon, and resorted to phlebotomy.

One of the highest peaks of the Shickshocks was climbed. and Captain Douglas' Union Jack unfurled at the summit, 3,768 feet above the sea.* The prospect from this mountain Logan afterwards described in the following terms:—

"From the highest summit we visited, the panorama displayed was of the grandest description. In the northern half of the circle, the waters of the St. Lawrence, dotted with its ships and fishing-boats, spread out to the right and to the left as far as the eye could reach. On its northern shore, immediately in

* Notwithstanding Logan's recorded protest, the mountain has been named after him

front, unaided vision could plainly distinguish the lighthouse of the Pointe des Monts, some fifty miles off, from which the granite hills, rising immediately behind it in the interior, gradually sunk below the horizon as they receded from us, following them down the expanding gulf, to a point where we thought we could discover the Island of Anticosti, one hundred miles away, in the mist of the distance; while at our feet were arranged in parallel lines the ridges and valleys of the lower land between us and the river. To the eastward a confusion of mountains and ravines belonging to the Notre Dame Range, filled up several degrees of the circle, and one summit, which exhibited a patch of snow, we supposed might be higher than the point we stood upon. Many of the peaks were bare, and as they retired one behind another, and occupied a smaller angle in the perspective, it became difficult to distinguish those of the Notre Dame from such as appertained to other ranges. Turning southward, a sea of parallel undulating ridges occupied the picture, the more distant of which we conceived might present a table-land, with a few marked points rising in cones and domes; and through one gap, which probably was the valley of some south-flowing river, we distinguished a faint blue horizontal line, which we fancied might be in New Brunswick. Prominent points became fewer veering westward, until the horizon was again interrupted in that direction by a well-defined outline of a not very distant part of the range from which we looked.

"The highest summits within our view were generally bare rocks. Those next in the scale were crowned with sturdy dwarf spruce trees, many of them not five feet high, but springing up so close together that their branches, interlocking, rendered it very difficult to make way among them. On those still lower, spruce became mingled with white birch, and the size of the trees gradually augmented in proportion to the decrease of elevation. One feature in the vegetation high up in the hills that struck us forcibly and gave us much satisfaction after confinement in the forest below, was the great extent of open glade that appeared on all sides but the north. Wide slopes on the east, the south, and the west, were carpeted with the most luxuriant growth and abundant specific diversity of ferns, from which clumps of spruce or of white birch, or of both mingled, started up here and there, giving the hills occasionally almost the character of park scenery, or as if art had arranged the distribution with a view to ornament, and often producing, in combination with peaks, ravines, and a distant horizon, landscapes of a very pleasing description."*

The various incidents of the Gaspé expedition of 1844 are recorded with the greatest detail in Logan's journal, from which the following extracts are taken:—

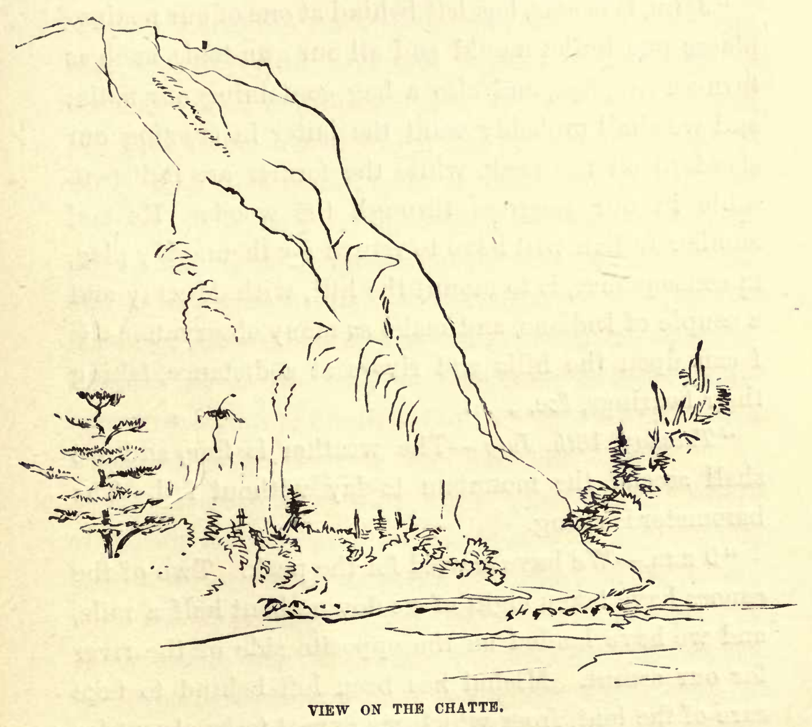
"*Thursday*, 11*th. July.*—I have no doubt the scenery is very beautiful, but we cannot see it for the trees. Our journey is like a sail up a canal cut through a wood, with this exception, that every now and then we have a rapid, and always a strong current. Once in a

* Report of Progress, 1844, p. 12.

while we have a glimpse of a distant hill, ahead or astern, when the river takes a bend. Just as we stopped this evening, about half-past six, we observed the footmarks of a porcupine on the margin of the stream in the sand, and we set one of the dogs upon the scent. He soon gave tongue. Michel followed, and at no great distance killed his game. So we shall have fresh meat for supper. Our frying-pan is up in the mountains, where our provisions are placed, and we shall have to roast the porcupine on a stick. We have no biscuits with us, and therefore we bake our flour every morning and evening after the Indian fashion, and eat unleavened bread in the manner of the Jews of old when they were in a hurry.

"The order of our procedure is this. We are in three canoes. I, Stevens and John in the first; De Rottermond, Frank and Louis in the second; Murray, Baptiste and Michel in the third. I have with me a micrometer telescope, by means of which distances can be measured. . . . I go first with my canoe, in which I have a pole with two oblong pieces of wood nailed across it. These are just five feet apart. Murray stays behind with the telescope. When I get to the furthest point at which we can be visible to one another, there I stop and hold up my pole, and while he takes his measurement with the micrometer telescope, I take the bearing between us by means of a prismatic compass. So soon as this is finished, Murray makes a signal, or I see his canoe begin to move. Then I start with mine, leaving De Rottermond in his to point out to Murray the spot when he gets up. By the

time he comes I am in the next station with my pole up, and so on we go. The greatest distance we have measured at a shot is about half a mile, but we could probably double that if the river permitted. . . . It is a capital river, and I will be bound for it, a river was never before measured through the forest in so short a time.



VIEW ON THE CHATTE.
Logan's Journal, 1844.

"*Sunday*, 14*th. July.*—Last evening we stopped about half-past five at the point nearest to the place of easiest ascent to the peak of the mountain range. Just as we

were about to do so, my canoe, which was ahead, came in contact with a porcupine which was crossing the river, swimming with just a small part of his head up Stevens gave him a knock with his pole, and we secured him in no time. This, with the game killed in the morning, and a partridge shot just over my head as I was employed in covering up my barometer, will supply our larder for a day or so

"John, it seems, has left behind at one of our resting-places our bullet-mould and all our gun-tools, such as turn-screws, &c., and also a bag containing our nails; and we shall probably want the latter in erecting our standard on the peak, while the former are indispensable in our progress through the woods. He and another Indian will have to return for them. My plan, in consequence, is to mount the hill, with Murray and a couple of Indians, and make as many observations as I can upon the hills and rivers at a distance, taking their bearings, &c. . . .

"*Tuesday*, 16*th. July.*—The weather is fine, and we shall ascend the mountain to-day without fail. The barometer is rising.

"9 a.m.—We have started for the peak. Two of the canoes have taken eight of us down about half a mile, and we have landed on the opposite side of the river for our ascent. Michel has been left behind to take care of the tent, from which we expect to be absent for two days. Our canoes are hauled up, and now for it.

"10 a.m.—We have risen 400 or 500 feet, after walking about half a mile, and the Indians, who have bundles on their backs, with blankets and provisions weighing

from twenty to forty pounds, have sat down to rest, and Murray is taking an observation with his barometer. We are all sweating, notwithstanding that the temperature is not above 62° F. in the shade

"There being no water near, the Indians have stripped the outer and second bark from a birch tree, and with their knives they are scraping the innermost bark from the stem. It is quite thin and pulpy, and they are satisfying their thirst with it. For curiosity's sake, I shall try the beverage. Capital it is! It is cool and has a faint sweetness which makes it very pleasant. Here is another use to which the birch-tree is put. It is a most invaluable tree to the American forest-rangers. The poor birch, which is a handsome tree, fifteen inches in diameter, has been peeled all around, and is now sure to die. About eight feet of the tree has been peeled, and it is as smooth and slippery as a greased pole. The Indians have been amusing themselves by trying to climb it, but they find it worse than a greased pole. None of them have succeeded. . . .

"*Wednesday*, 17*th. July.*—We were all up pretty early, not feeling quite so warm as usual. . . . The height we are at is upwards of 3,000 feet above our tent, and that may be some 300 feet above the sea While John was preparing our breakfast, which he said would require an hour and a half, Louis, Murray, Stevens and I started to take some sights on the south side. . . . We had walked an hour, and as it seemed to me that there was a sort of connecting ridge between the ridge and the peak, I resolved to try for it, and sent Louis back to say so, and to desire John to establish

his camp at the base of the said peak, by the side of one of the mountain streams. Louis has to go back to the river tent in the course of the day, for more provisions, as it is evident we have not got enough to last us the time we shall be on the summit of the mountain. Having found one of the antlers of a caribou as we went along, I told Louis to carry it back to the tent, in the hope of finding some means hereafter of getting it up to Montreal.

"So we separated. Away I posted down the hill to cross the ravine, in which I soon succeeded; but I found great difficulty in proceeding along the ridge connecting the knob mountain with the peak, and it was two hours before I got to the summit, as tired as possible, and as hungry as a hawk. . . . Thunder-clouds now began to show themselves to the westward, and the thunder gave a threatening growl, which was sufficient intimation that I should be better off down below in the valley than on the bare, stony mountain-top, without covering. So off I started to make for the smoke as quickly as possible. The way I chose was along a gulley, in which flowed a small mountain torrent, and there not being many trees, I stretched on at a famous rate, bounding over all impediments, and occasionally sliding on my back for some distance when my foot slipped on the wet herbage. When I had nearly reached the valley I heard a halloo above me, which I answered; but I kept on for the smoke, which I reached just in time to save a ducking. As I came down the hill there was a vivid flash of lightning, and a quick and awful crash of thunder right behind

me. I am persuaded the peak must have been struck. After this, successive thunder-peals roared among the mountain-tops, giving us a salvo of heavens artillery to welcome our arrival amidst the majestic scenery of Shickshock.

"When I reached the tent it was one o'clock, and I was desperately hungry. So the first thing that was done was to heat some of the porcupine *bouillon*. . . .

"7 p.m.—We are all patching small leaks in our covering, in order to sleep as dry as we can. Our provisions being rather short, we go to bed supperless. The poles of our cabin are spruce, and wherever the branches have been cut gum oozes out. As we sit the poles touch our heads, and a multitude of the drops of gum have attached themselves to my hair. . . . De Rottermond seems to be the most uncomfortable one among us; but instead of attributing his great discomfort to some quality within himself, he seems to imagine that it always arises from something peculiar to his place in the tent. Either there is more smoke where he is than anywhere else, or the fire is further from him than from anybody else, or the ground is wetter where he is, or there is some chink in the tent which lets in the wind where he is, or the flies bite most where he is.

"*Thursday*, 18*th. July*.— . . . 8 p.m.—We have had a grand day on the peak. It has been windy, but bright, with the exception of one squall, which brought clouds about our ears. But they cleared away again in a short time. We have planted the Union Jack Captain Douglas gave us. . . . The 'Unicorn' passed

just as we were about to raise it, but we could not get it up in time to give a fair chance of its being observed. I drew a panorama of about one-half of the circle of hills, and hope to finish to-morrow. We have measured sixty-three angles to various peaks, and if we can determine the distance to the next high western peak, we shall fix a great many points on our forward journey. . . . Drawing with a temperature of 43°, and a strong wind blowing, is anything but warming for the fingers. We had scarcely a single black fly the whole day—thanks to the wind."

Passing over an interval of several weeks, we find Logan and his party in the country to the south of the Shickshocks, making their way through to the Cascapedia. The journal was still faithfully kept up, and from it we again quote:

"*Monday, 12th. August.*— . . . The order of our march is this: John goes first in the direction indicated by me for the day, after due consideration. Louis follows, and these, with their axes, as they go, clear the branches a little. I follow next; then comes Murray, and then Stevens. The rest follow in what order they choose. . . . As I follow in my place after John and Louis, I count my paces, making such allowances as I judge fit for zig-zags and short steps necessary to avoid stumps and to get over windfalls; and thus our distance is estimated approximately. If I come to any geological feature I note it down in its relative place, and as every now and then we have bearings on the hills, the whole will ultimately be given with considerable correctness. The general level of the land

since we quitted the mountains is rather above 1,000 feet over high-water mark. We take barometrical observations at every resting-place, and we thus hope to get a profile of the country across to the other side.

"7 p.m.—We have returned to our tent after locating our provisions at a spot about three and a-half miles distant. Our third resting-place was at the foot of a small hill, to the summit of which we ascended, leaving our packs below. From it we had a good view of our flagstaff on the peak. . . .

"*Tuesday*, 13*th. August.*— . . . John has our tent pitched by the side of a small brook, the water of which flows to the Baie des Chaleurs. We have thus crossed the water-shed, and Stevens says he feels as if he had already arrived at the bay. The water is very cold, and the Indians say it has not the same taste as that of the Chatte, notwithstanding it flows from the same source (some of the small lakes discharge two ways). In this cold water we have washed the blood of the fly-bites from our hands and faces, and having made ourselves comfortable, now for supper. The flies have been very troublesome. Murray swears that he has brought only the half of himself home. Stevens has lost a handkerchief, and I have lost my gloves. I am very tired. My shins are black and blue all over with thumps against stumps and fallen trees, and my foot has been squeezed by getting into the fork of a root. I shall sleep without rocking.

"*Wednesday*, 14*th. August.*—I went to bed immediately after supper, and was up this morning at five. The cold would not let me sleep, and I had to get up

twice during the night to warm myself. John kept on a rousing fire, which it was a comfort even to look at. . . It was nine o'clock before we could get our supper, and I had tasted nothing from 7 a.m. We took no dinner on our journey yesterday, for want of water. All the men were thirsty, and none could eat without drinking first.

"On cracking a stone which had been baked under our fire at breakfast this morning, I found a trilobite in it, and this induced me to search the river for more, and though I have got only another fossil, a shell, I have found many angular, flat fragments of sandstone with carbonized comminuted plants, identical in character with the Gaspé sandstone. This and the fossils discovered in the limestone and shale on the middle fork of the Chatte induce me to be nearly certain that I have a clue to the elucidation of the geology of this part of the country. From the middle fork to this point all the indications of strata we have seen have been calcareous, and I am of opinion that all we have passed over are equivalent to the Gaspé limestone. Such being the case, there should be a great display of sandstone with carbonized plants on the top of the limestone, and as the measures, wherever I have seen them in our progress, have but a moderate dip, the sandstone, which is not under 4,000 to 5,000 feet thick, will be spread over a great surface of country to the south, particularly if at the same time it undulates a little, which it does on the coast. *Nous verrons.*

"*Friday*, 16*th. August.*— . . . The men with the provisions have returned, perspiring like heroes. The

day is warmer than usual. They have brought a partridge with them. Breakfast, however, is not quite ready yet. It requires considerable time to arrange a porcupine for cooking when the skin is to be left on it. It is necessary to pluck off all the quills, as the feathers are plucked off a bird, and then to singe the small and long fine hairs, and scrape them off with a knife. The skin is thick, and there is a great deal of nourishment in it. It is, therefore, a great loss of provisions to take it off the animal, as is sometimes done when we are in a hurry.

"6 p.m.—We have been to the summit of the Conical Mountain, and taken our sights there, and fixed the position of it on our map. We see to the south of it a branch of the Cascapedia coming from the west, which is of considerable size, being larger than the Chatte where we left our canoes. Another branch joins this somewhere in the neighbourhood, coming from the east, and the main stream must be a very considerable one. The small quantity of rock visible in walking through the woods induces me to think I should see more of the geology of the country were I to navigate the river. The difficulty in the matter is the want of canoes. The Indians say they can make such as will serve, of spruce bark. They are not so good as birch, but they can be made more expeditiously. One of them can be constructed in a day. We shall require three, or at least two. I consider that we are forty miles from the sea in a straight line, and and probably sixty with the bends of the river Lumber is cut on the river lower down, but I do not

think that either Indians or lumbermen have been so far up as this. After getting down ten or twenty miles, we may fall in with Indians fishing, or with lumbermen, and in such case we may improve our style of conveyance. The country to the eastward of us is mountainous, but that to the westward is much less so The ridges run parallel to one another.

"*Saturday*, 12*th. August.*—It has rained all day, and no one has stirred from the tent. It has been resolved to take the Cascapedia River by canoes. We shall start to-morrow morning after breakfast for that branch of the river which is near us. The men propose to carry their burdens at one trip. They will have about eighty pounds apiece to groan under. I shall have about twenty-five pounds; Murray and Stevens about as much, with the addition of the barometers.

"*Sunday*, 18*th. August.*—We have at length arrived at the western branch of the Cascapedia River, after a very weary and toilsome march of about three miles round the eastern base of the Conical Hill, which is trap, breaking through the sandstones of Gaspé and Douglastown on the coast. We killed a porcupine as we came along, and Rose got her head and face full of quills. . . . We travelled for most of the distance in a valley, which contains a stream that had to be crossed half a dozen times; and we had to make our way through alders and other small shrubby trees which twist and interwine in such a manner as to make our efforts among them very much like those of animals entangled in a net. I had several tumbles and slides, and my feet and legs sank into deep holes when I did

not expect it. Branches also scraped my face, and dead sticks were punched into my stomach. When I tried to save myself by catching hold of the trees near, I occasionally got hold of a dead one, which came tumbling on the top of me. It was like walking in a night-mare. . . .

"It was a great satisfaction to get to the river, for my 25-lb. pack seemed a load for a horse. We came down the stream after reaching it, and found a most beautiful place for our tent. The river may be sixty feet wide, and the effect even this pretty opening has on one after having travelled for ten days among the trees, like a beetle in a hay-field, is most pleasing. . . . There is quite water enough for canoes, and when it is considered that the branch we are on is only one of many much larger which we shall meet lower down, there can be no doubt that our craft when built will float. Louis commences the canoes to-morrow morning.

"I have ascertained the variation here to be 19° to 21°. While at our last tent I reduced the ascertained position of the Conical Mountain to paper, and by it we have proved that at the Old Man Mountain there is a local attraction which deflects the needle five degrees from its true variation. There is, perhaps, some vein of magnetic iron ore in the neighbourhood.

"*Monday*, 19*th. August.*—John went out before breakfast, and got two partridges. Louis has set vigourously to work at his canoes of spruce-bark. He is preparing the wood which is to bind the edges. Baptiste has been out for cedar to form the timbers and ceiling. John has brought in spruce-roots with which to sew

all parts together, and every one is busy. Murray and Stevens are washing their clothes. John informed me that while on his cruise in the morning he saw red rocks a little way down the river. I shall march off and have a look at them. From his description, I suspect they bear a strong resemblance to the red sandstones of Long Cove.

"4 p.m.—I have returned from my examination of the strata below, and find them exactly what I expected, red sandstones and shales, with ripple marks, crack casts, upright plants, carbonized comminuted plants, and all the characteristics of the Long Cove rocks. The dip is not exactly what can be called regular, but it denotes that the trap-dyke of the Conical Hill has an important effect upon the stratification. The rocks lean upon the trap range.

"As I returned I found Louis, Baptiste, and Michel busy taking the bark off the spruce tree with their knives. The tree would not peel well, and I was sorry to hear on my arrival that one bark had been spoiled already. . . . John says that it is beginning to be rather late for peeling spruce trees.

"5 p.m.—The men have returned without bark. It would not quit the tree, and the knives not being of the proper form, it was cut through and spoiled. I begin to fear our canoes will not be made. This will be a sad disappointment, as I am persuaded that more of the measures will be seen on the stream than anywhere else. We must not despair, however. Another tree must be tried to-morrow or to-night, as soon as the men have had something to eat.

"The men are off across the river to try the other bank for a tree. They had to wade across. Stevens has accompanied them. He has taken off his trousers to cross, and will be nicely bitten by the flies, as I know from my sad experience. I have had to strip three times to-day, and to remain stripped on one occasion for half an hour. The men have returned with a roll of bark fit for a canoe. It is about fourteen feet long, and rather more than six feet wide. . . .



PORTRAIT OF LOUIS.
Gaspé Journal, 1844.

"*Tuesday*, 20*th. August.*—Murray, Stevens, and I have been up the river about a couple of miles. We came to the spot where the trap crosses it, and found the sandstone on the east side of the dyke, and the limestone on the other—fossils in both. I dialled and paced the whole distance, and shall be able to exhibit

the relations of this section to the one down the river. So that I consider we have done a good day's work. . . .

"*Thursday, 22nd. August.*—The third canoe is finished, and is a most respectable craft. It is eighteen feet long, two feet nine inches wide, and fourteen inches deep. It will carry an extra cargo. . . .

"*Friday, 23rd. August.*—We have started on our voyage, and come down two miles, dialling the river all the way, and taking the distances with the micrometer telescope. . . . John and Michel have left us to return to the Chatte. The river will now be our pilot. . . . We killed a partridge as we came along, and we are all praying for the chance of porcupines. But our best dog, Toolose, has left us with Louis. . . .

"*Sunday, 25th. August.*— . . . It has rained all day, and as the evening approaches, the rain increases. The red sandstone continues up to this point, and I think I see what the structure of the country will be. I fancy that we are in a trough, of which the sandstone forms the upper rock, and that towards the south we shall have a repetition of the measures on the north; that we shall again cut the limestone, and then meet with metamorphic rocks similar to those constituting Shickshock. . . .

"*Monday, 2nd. September.*— . . . The morning is cloudy; but it is early yet, being about 5 a.m.

5 p.m.—We have dialled down about twelve miles. The day has been cloudy, and at length it has begun to rain, so we have pitched our tent an hour earlier than we otherwise should. Our instruments are wet, so are

our books, and so are ourselves. A little after the middle of the day we at length met with people from the mouth of the river. First came a man and his wife in one canoe, with three boys in another. The man, an old one, informed us that we were at the time seventeen miles from the sea. We gave him two charges of shot. Shortly afterwards another canoe, with two men in it, met us, and one of the men informed us that we were twenty miles from the sea. . . . Still further down, we met two more canoes, and a sedate old man in one of them told us that we were twelve miles from the sea. His account agrees pretty well with mine. . . .

"*Tuesday, 3rd. September.*— . . . This river is certainly a very beautiful one. It has a pretty regular breadth of from sixty to seventy yards, with occasional gravelly banks. Now and then solid rocks peep out from the border, giving sudden turns to its course, and producing deep and smooth pools for the convenience of salmon and trout. . . . The wood hereabout is not so dense as higher up the river, and there are many marks of the lumberer at every turn. The large pine seems, however, to have all been cut down. . . . I should not think the Cascapedia a very profitable lumbering stream.

"Our sugar is finished; so no more tea for me. We have only enough fish to serve for the men's breakfast to-morrow morning. Flour and a little ham is all our stock. . . .

"*Wednesday, 4th. September.*—The rain continued until about midnight. At four this morning the stars and moon were shining brightly, and now at six the sun

adorns the tops of the hills. The wind has died away, and though a mist prevails on the river, it is gradually dissipating, and by the time we have had our breakfast the atmosphere will be clear enough for us to carry on our work. . . .

"6 p.m.—We have again got into the region of civilization, or semi-civilization. We reached the first clearing about 1 p.m., and were very glad to see it. There was no inhabitant on it, but we expected that inhabitants might be on the next. A crop of grain was growing on it, still quite green, and whether wheat or oats, it says little for the climate of these parts. . . .

"*Friday, 6th. September.*—The weather continues fine, and we shall get to salt water to-day. We must purchase two canoes forthwith. Our temporary spruce-bark vessels have begun to leak, and mine has a crack four inches long in it, which will increase in spite of all our gumming. . . .

"6 p.m.—We have pitched our tent upon the west side of the river, at its mouth, close by a settlement of Indians, who live in sugar-loaf wigwams. They have several canoes, and as I have obtained money (hard dollars) on my letter of credit, I have no doubt of obtaining a couple at a fair price. I obtained the money from Mr. Cuthbert, the great man and shop-keeper of the district. Murray, Stevens, and I called at his shop, which is about a couple of miles on the other side of the river, round a point which projects into the bay. When I reached his house he was not in, being on a visit of inspection to his shipyard, where he has a large vessel on the stocks. . . . So we had to wait for

him nearly three hours. The reception the clerks gave us, particularly the head one, was rather cavalier; but really no wonder, for we are pretty figures. I fancy I look like a wandering old-clothes man, who wears the clothes he deals in, and my companions look no better. But when Mr. Cuthbert came home, we found him another sort of man. He is a Scotchman who has planted himself here, and by attention to business he is fast making his fortune. He knew who I was the moment my name was mentioned. . . ."

Having reached the Baie des Chaleurs, Logan spent several weeks examining the coast between the Cascapedia and Metapedia Rivers. The nights were now growing cold, and accordingly, as evening came on, he often sought some farm-house, where he enjoyed not only the shelter of a roof, but the simple ways and kindly hospitality of even the poorest among the settlers. His journal tells us something of this:—

"*Thursday*, 4*th. October.*— . . . As it became dark I came up with a Frenchman, as he was returning from his fields, where he had been cutting corn. He and his daughter were driving their cattle home. Being on the look-out for quarters, I entered into conversation with him, and after a little talk about his crop and a great fire which had burnt up the wood on the mountain flank in the rear of his lot, I asked him where I could find a house to sleep in. He said that if I were willing to take up my abode with a poor man, I was welcome to his house. I required no further invitation, and into his house I went. The first thing I did was to bring up my notes, and the next to partake of supper. . . .

While I was writing the old man was reading, and after supper I had the benefit of his learning. In the course of conversation he made mention of Spain, and asked me whether Spain was under the dominion of France or of England, and was made aware for the first time in his life that it was an independent country. He asked me if Louis XVIII. was still on the throne of France, and was surprised to learn that he was dead, and that his successor, Charles X., had been sent adrift, and that Louis Philippe was the king. He asked what had become of Philippe d'Orleans, and was surprised to find that he was the king. He said that in the book he had just been reading he appeared to be a republican, and had raised 60,000 troops for the Republic.

"His book was an old one, without covers, and with an abundance of dog-ears, and it was amusing to find how he considered the events he was reading of as having just happened, never thinking that time had been running on since the days of his youth. He looked upon history as I have known people look upon those who have been absent for a long time, expecting to find them exactly the same when they next see them as when they parted. I remember on my return to Montreal, when I was about twenty-five years of age, Miss Fanny Hayes, on seeing me, whom she had last seen when I was at school, expressed her great surprise that I had grown so. . . .

"*Tuesday, 5th. October.*—I have returned to my Indians on the beach. The historian's house was most amazingly warm last night. His stove must have been nearly red hot. . . . The Indians had appointed the

ferry-house as a rendezvous, but when I got to it, it was quite dark, and they had gone across to the other side to camp in the wood, there being no trees on this. I was content to take up my quarters with the ferry-man, telling him I would pay him for my lodgings. His house has but one room in it, and he made fifty excuses, but said he would do his best for me. He was alone in the house, but said his wife would soon be home and prepare me something to eat, though he feared it would be but a poor man's meal. The wife soon came in, puffing at a fine rate. She had been milking the cows in the rain and cold, and had run home, followed by five little children. . . . The little ones were all much of a size, being between the ages of two and ten, and what with the bustle of the mother, and the squalling of the children, there was noise enough. There appeared to be only one bed in the room, and the whole house was not more than fifteen feet square. It seemed to be stuffed with commodities, however, and I saw six or seven bowls of milk on a hanging shelf, which made me aware that I should not starve. And the *bonne femme* soon proved it; for, continuing to puff and blow, she set about preparing me *mon repas*, as the ferry-man called it. She baked some barley scones, boiled four eggs, and the *bon homme* asked me whether I would have milk or sugarless tea. 'Milk,' said I. So milk, barley scones, butter, and eggs were placed before me, and I did justice to them. While I was supping the *bonne femme*, still puffing and blowing, put the great kettle on the fire, and burnt her fingers in so doing, which made her puff and blow the

more. She filled the kettle with potatoes, and prepared a second supper for the men. Her husband and the two men got their potatoes, herrings, and milk when I had finished, and the *bonne femme* and children followed them. There is but one table, as there is but one bed, in the room. There are two chairs, however, a large chest which may be considered a sofa, and a wooden block which serves for a stool. So soon as all had supped, I set about writing up my notes, and the *bonne femme*, always in a bustle, began to arrange the room for repose. A low bed was pulled out from below the high one, where it had been like the lowest drawer in a chest of drawers, and it was placed in the centre of the room before the fire. . . . Then the children were all made to say their prayers, one after the other, and each, as the prayer was finished, was laid in the little bed, beginning with the youngest. One, two, three, were placed with their heads one way (each end of the bed being furnished with a long pillow). The feet were all mingled together, and each one was obliged to take care of his own. I suppose the hardest kicker usually gets the most room. All being placed, a great coverlet was thrown over them, and then the day's work seemed to be nearly done. The *bonne femme*, still puffing and blowing a little, got hold of her knitting-needles and an unfinished stocking, and made some further progress towards its completion. But soon I had finished my notes, and then it was time for me to get repose. I was told the big bed was for me. It seemed almost extravagance to take up so much room, while there were still so many without any.

However, I went to bed. The two men laid down on the floor, with their feet to the fire, and the *bonne femme* began her prayers. She prayed most busily, as it appeared to me, puffing and blowing even then, for her words came now loud, now in a whisper, and she prayed inhaling as well as exhaling. She must have repeated a considerable number of *Pater nosters*. I fell asleep before she and her husband had lain down, but was curious to know how and where they would bestow themselves. On awaking this morning, before any were up, I perceived that the good man had laid a mattress on the floor, between the fire and the small bed, and that the *bonne femme* had found room for her body on the small bed among the five children, and for her legs on the husband's mattress. The room was a singular picture."

On the 11th. of October, Logan left Campbellton on his homeward journey. Though so late in the season, he ascended the Metapedia River as far as Lake Metapedia, in a bark canoe, and there began the long, tedious drive of more than 400 miles to Montreal.

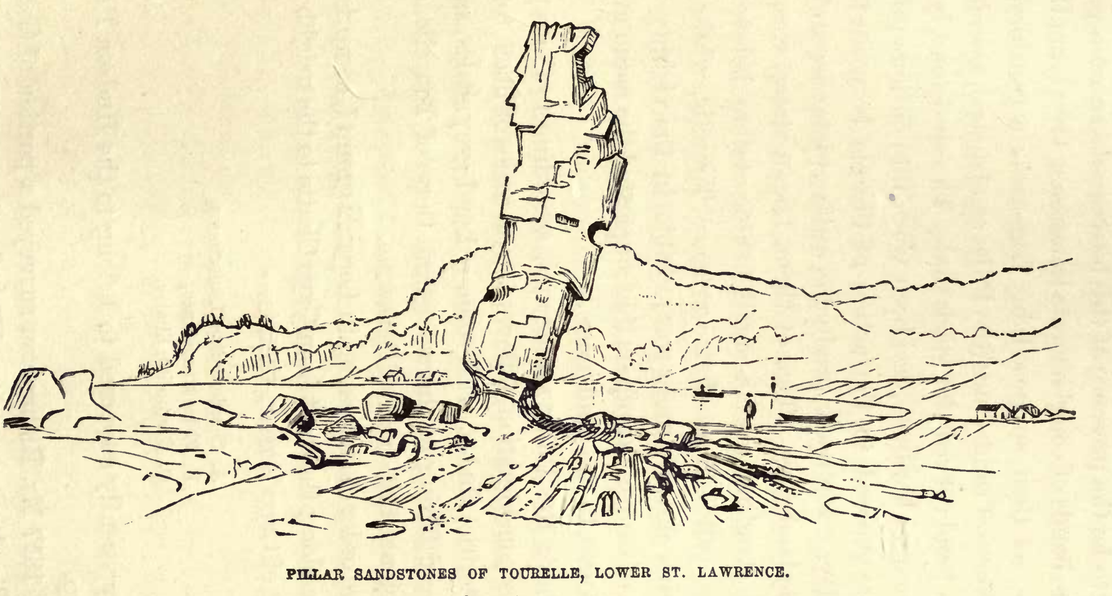
The work which he accomplished in the Gaspé peninsula during the first two years of the Geological Survey, formed the sure foundation upon which several members of his staff afterwards built. Murray in 1845, Richardson in 1857 and 1858, Bell in 1857, and again in 1862, continued the Gaspé explorations, and the results of their various and valuable surveys are to be found summed up in the *Geology of Canada*. After his second season's work, Logan submitted to the Government a most interesting report on the region, in which

he describes everything he saw with striking accuracy and minuteness of detail. The four groups into which he then divided the various strata met with, in the main hold good to-day, and are as follows, in ascending order:—

I. Conglomerate Limestone, Pillar Sandstones, and Graptolitic Shales.
II. Gaspé Limestones and Calcareous Shales.
III. Gaspé Sandstones.
IV. Limestone Conglomerates and Red Sandstones.

With regard to each of these divisions, a few remarks may be made:—

I. CONGLOMERATE LIMESTONE, PILLAR SANDSTONES, AND GRAPTOLITIC SHALES.—This group includes various members of the series which Sir William afterwards called the Quebec Group, as well, perhaps, as strata of the Hudson River formation. At the time, he probably regarded the whole as belonging to the latter; but in after years, when the fossiliferous rocks of the Quebec Group were proved to be older than even the Trenton formation, the position of the supposed Hudson River rocks on the south shore of the Lower St. Lawrence was regarded as due to the eastward extension of a great line of fault, of which we shall speak elsewhere. According to his description, the lowest rocks of group I. observed in that portion of the St. Lawrence coast section which he examined in 1844, are conglomerate limestones, oolitic limestones, compact limestones, black bituminous shales, red and green argillaceous shales, calcareous sandstones, &c., having altogether a thickness of about 1,140 feet. Some of the beds are described as containing a black substance resembling "good sea-coal," and the "distin-



PILLAR SANDSTONES OF TOURELLE, LOWER ST. LAWRENCE.
Note Book, 1844.

guishing characteristics" of the deposits, as a whole, are said to be the presence of this bituminous substance and of the bands of conglomerate limestone. Overlying these beds—as then supposed by Logan—is a considerable thickness of sandstones (the Pillar sandstones), associated with bands of red and black shale. The sandstone, being of unequal hardness, has been worn into curious pillars where exposed to the action of the sea between high and low water mark, producing quite a picturesque effect in the landscape. Two of them, Logan states, were, in 1844, standing near a small fishing-station below Ste. Anne, called from their presence Tourelle, while the remains of many more were visible in the vicinity. It was, of course, the pillars that suggested the name given by Logan to the sandstones.

Above the Pillar sandstones, according to the report under consideration, follows a great series of black (often graptolitic) shales, with some red and grey shales, sandstones differing in character from those of Tourelle, and occasional thin beds of limestone.

The order of succession in Logan's group I, comprising rocks along the coast from Cape Chatte to the neighbourhood of Cape Rosier, then is—

A. Conglomerate Limestones,
B. Pillar Sandstones,
C. Graptolitic Shales,

all apparently supposed to belong to the Hudson River group.

In 1857 Mr. Richardson surveyed a portion of Gaspé, and in his report,* published, of course, with the

* Report of Progress, 1857, p. 46.

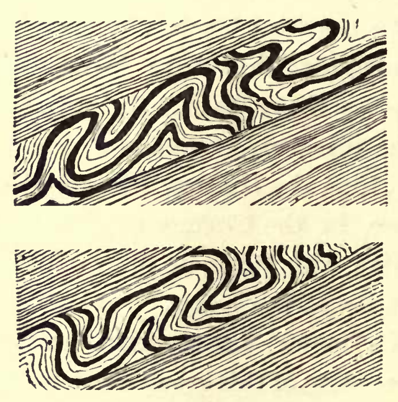
Director's approval, there is a change in the order of superposition just given, the Pillar sandstones being placed at the top and the graptolitic shales at the bottom of the series, thus:

A. Graptolitic Shales,	Lower Silurian.
B. Conglomerate Limestones,	
C. Pillar Sandstones..........	Middle Silurian.

A. and B., Richardson says, are supposed to be representatives of the Hudson River group, while C. is looked upon as equivalent to the Oneida conglomerate, and also to the sandstones near Quebec, to which the name of "Sillery Sandstones" had been given. Subsequently, as is well known, the rocks of A. (in part), B. and C. were shown by the discovery of fossils at Point Levis to be more ancient than the Hudson River formation, and all of them were, in the *Geology of Canada*, described as Lower Silurian, the Pillar or Sillery Sandstones being placed at the top of the series.

GROUP II. GASPÉ LIMESTONES AND CALCAREOUS SHALES.—The rocks of this group are described by Logan as occupying the promontory of Cape Gaspé, and were also met with in the traverse which he made across the peninsula. The whole group, including limestones and shales, was found to have a thickness of about 2,000 feet, and although its exact relations to the rocks of the underlying series were not at the time certainly made out, it was afterwards shown that it rested uncomformably upon them. Some of the limestone beds are abundantly supplied with organic remains, of which large collections were made; but, unfortunately, the vessel by which most of them were being taken to Quebec was wrecked

on the coast of Labrador, and the precious specimens lost. In their absence Logan wisely avoided giving any very distinct utterances with regard to the equivalence of different parts of the group. He, however, recognized in some of the beds fossils which were interpreted as belonging to the "New York Helderberg Series." In the *Geology of Canada*, the group is divided into eight subdivisions, and it is stated that "the limestones of Cape Gaspé appear for the most part to belong to the



CURIOUS BEDS OF CORRUGATED LIMESTONE IN SHALE, CAPE GASPÉ.
Geology of Canada, p. 392.

Lower Helderberg group. The fossils at the summit, however, bear a striking resemblance to those of the Oriskany formation, with which several of them are identical. It appears probable, therefore, that we have here a passage from the Lower Helderberg to the Oriskany, and the latter formation may be more especially represented by the lower part of the Gaspé sandstones." Subsequently, when Billings had studied the fossils more thoroughly, he wrote: "The two lower

divisions (1 and 2) are most probably Silurian; about the age of the Helderberg of the New York Geologists. The upper two members (7 and 8) are nearly of the age of the Oriskany sandstone, and are therefore about the base of the Devonian. Divisions 4, 5, 6 may be regarded as constituting passage beds between the Upper Silurian and Devonian."* The following table, from the same work as the above extract, gives a concise view of the subdivisions of the group:

THE GASPÉ LIMESTONES.

	No.	Description	FEET.
Devonian.	8.	Grey limestones, in beds from six to twelve inches thick, some of them holding schist at the summit...........	500
	7.	Grey nodular, shaly limestone, with greenish calcareo-arenaceous shales at the top........................	300
Passage Beds.	6.	Grey calcareous shales or shaly limestone, interstratified, particularly at the top, with beds of purer limestone fit for burning....................................	300
	5.	Grey, greenish, and dark grey calcareous shales, with beds of arenaceous limestone............................	380
	4.	Grey limestones, in thin beds, with some olive-green shales.	200
	3.	Olive-green calcareo-argillaceous shales, with nodules and layers of compact limestone.........................	170
Upper Silurian.	2.	Greenish calcareo-argillaceous shales, which are interstratified with less calcareous layers, of various shades of red..	90
	1.	Grey limestones in layers of from six to eight inches thick, which are separated by bands of greenish calcareo-argillaceous shale, gradually increasing in amount towards the top.....................................	70

GROUP III. THE GASPÉ SANDSTONES.—This series, succeeding the calcareous group No. II., is extensively developed on Gaspé Bay, and, according to the measurements of Logan, has a thickness of about 7,000 feet.

* Palæozoic Fossils, Vol. II., Part I., August, 1874, page 2.

Though in the main a sandstone formation, it includes considerable thicknesses of shale and coarse conglomerate, and not far from the base a thin seam of coal and carbonaceous shale (together measuring 3 inches) was met with. Trap dykes were observed cutting the strata in a number of localities, and the occurrence of petroleum in druses noticed in one of them. Two petroleum and two sulphurous springs in the neighbourhood of Gaspé Bay were also examined, and attention called to them by Logan in his report.* Many of the sandstones were found to contain remains of plants, which have since been studied and described by Dr. Dawson.

With regard to the age of the group, Logan says in his report for 1844, p. 43: "Reference has already been made . . . . to the existence of a small, but regular, seam of coal found towards the base of the series. It is not, however, to be inferred from this that the group belongs to what is emphatically called the Carboniferous era, or that there is much probability of discovering the mineral associated in sufficient quantity with its strata to render it profitable to mining enterprise. Though 7,000 feet of vertical thickness, with very little defalcation, have been carefully examined in continuous succession, nothing like a workable seam, nor anything but this one like a regular seam, or like a seam at all, has been met with; and while some of the fossil plants and the lithological

* Since Logan visited the region in 1843, petroleum has been observed in a number of localities in the vicinity of Gaspé Bay. The springs have, however, nowhere been found to yield large quantities of oil, nor have the borings which have been undertaken proved successful. The oil sometimes issues from the Gaspé limestones, but more frequently from the overlying sandstones. The rocks have been thrown into a series of gentle undulations, and it is chiefly along the anticlinal axes that the oil occurs.

character of the whole series appear much to resemble what in the New York succession is termed the Chemung and Portage Groups, with perhaps the addition of what the geologists of that State term their old red sandstone* (though I have no distinguishing mark by means of which to establish a division in Gaspé), there is still to be described a set of rocks which, in Gaspé as in New York, overlie these, and belong to the Carboniferous series, though the part resting in Canada appears to be too low down to be associated with the profitable seams of coal."

In the *Geology of Canada*, p. 404, the first 5,000 feet of the series are said to "present analogies with the whole series of formations in New York, from the Marcellus shales to the summit of the Chemung sandstones; in all of which, according to Dr. Dawson, are found several of the species of plants that occur in the Gaspé sandstones. The whole of these 5,000 feet resemble, lithologically, the Portage and Chemung sandstones of New York; and it may hereafter be found that in this eastern part of the continent, the Oriskany fauna which occurs at the base of this Devonian series merges gradually, towards the summit, into that of the Portage and Chemung group. In lithological characters the remaining upper 1,800 feet of the Gaspé series resemble the Catskill group of New York." No mention, it will be noticed, is here made of the Corniferous formation, but in Logan's Geological Atlas the Corniferous is included among the New York formations equivalent to the Gaspé sandstones; showing that he looked upon the latter as representing the entire

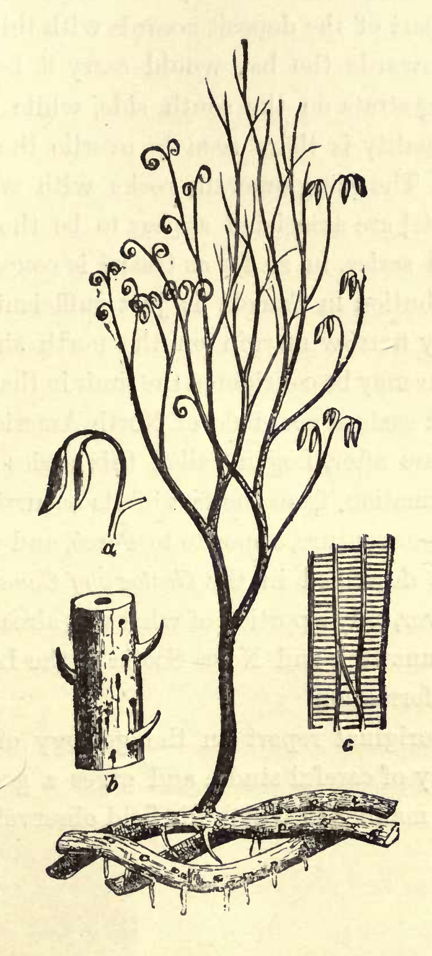
* The Catskill group.

Devonian series of the New York geologists. As we have already seen, Billings, in 1874, placed the base of the Devonian 800 feet or more below the summit of the Gaspé limestones. This, of course, was on the supposition that the Oriskany formation belonged to the Devonian, and not to the Upper Silurian, as some geologists hold.

More recently exposures of the Devonian sandstones and shales have been found on the Baie des Chaleurs containing numerous fossil fishes of characteristic Devonian genera, and fossil plants, some of which are of the same species as those occurring at Gaspé. The fishes have been described by Mr. Whiteaves and the plants by Dr. Dawson.

Notwithstanding the great thickness of the Gaspé sandstones, their geographical range is much more limited than that of the underlying limestones, which extend all the way from Gaspé into Massachusetts.

IV. Limestone Conglomerate and Red Sandstones.—This next great series of Logan's report is extensively developed on the Baie des Chaleurs, and is described as consisting of red sandstones, interstratified with coarse calcareous conglomerates, the whole having a thickness of not far from 3,000 feet. Its unconformable superposition upon the Gaspé sandstones and limestones was recognized by Logan, and its relation to the Carboniferous of New Brunswick correctly ascertained. On page 66 of his report Logan says: "In thus tracing the upper conglomerates and sandstones round Bay Chaleur to Bathurst, their relation to the nearest coal seams of the New Brunswick Carboniferous area is made out with a



RESTORATION BY DR. DAWSON OF PSILOPHYTON PRINCEPS,

The most characteristic plant of the Lower Devonian of Gaspé.

One-fifth natural size.

(*a*). Fructification.
(*b*). Stem.
(*c*). Scalariform Vessels, ...

considerable degree of certainty. The general dip of the Canadian part of the deposit accords with this relation; its slope towards the bay would carry it beneath the coal-bearing strata on the south side, while no rock of a similar quality is there seen to overlie the coal measures. . . . The conglomerate rocks with which they [fossil plants] are associated appear to be the very base of the coal series, in so far as Gaspé is concerned, and their distribution in Canada is just sufficient to show that a very narrow margin on the north shore of the Bay Chaleur may be considered the limit in that direction of the great eastern coal-field of North America."

Some years after, Logan called this series the Bonaventure formation, from the fact of its occurring on the island of Bonaventure, opposite to Percé, and under this name it is described in the *Geology of Canada*, p. 404. It is, however, only a portion of what was already known in New Brunswick and Nova Scotia as the Lower Carboniferous formation.

Logan's original report on the geology of Gaspé is well worthy of careful study, and gives a good idea of the careful manner in which his field observations were made.

CHAPTER XI.

EVENTS IN 1845 AND 1846.

THE winter of 1844-45 was an anxious one for Logan. The sum of £1,500 originally granted for the Geological Survey of the Province was all gone, besides more than £800 which had been paid from his own pocket. No one could tell whether the Survey would be continued or not. Some even said that had the Government supposed the £1,500 would not be sufficient to complete the work, they never would have consented to its being begun at all. Shortly after his return from Gaspé, he was requested by the Government to prepare an estimate of the cost of continuing the Survey in an efficient manner. This was done, and a bill also drawn up and submitted for the consideration of the members. The bill was a model one, covering all necessary ground, and yet free from the redundancy of expression so common in documents of the kind. As we shall see, it met with the entire approval of the Government, and, largely owing to Logan's own untiring exertions, soon became an act.

And never was there a bill passed concerning which the members had fuller information ; for in his own quiet way he had talked and talked, written and written, to them individually, until he had succeeded in kindling in the breasts of many no little of geological enthusiasm. They in turn recognized in him a man thoroughly in earnest and in love with his work, and wisely saw that his labours could not fail to be of advantage to the country. Be that as it may, through the passage of the bill provision was made for the continuance of the Survey for five years, with an annual grant of £2,000.

But scarcely was this settled, and plans made for the summer's field-work, when overtures came from a new and unexpected quarter. The Court of Directors of the East India Company were anxious to have a survey made of the coal-fields of India, and were in quest of a thoroughly competent geologist to undertake the work. Sir Henry de la Beche was consulted in the matter, and the result was that shortly after the appointment was offered to Mr. Logan. De la Beche himself, although unwilling to influence his friend in the matter, was evidently anxious that he should accept the offer, and wrote to him as follows :—

"LONDON, 29*th. March*, 1845.

"MY DEAR LOGAN,—You will probably receive by this mail a letter from Dr. Falconer, confidentially instructed by proper parties, connected with the Directors of the East India Company, to write to you about examining India for coal. Whether or not it may suit you, your name was mentioned by us here as the proper person to apply for, if you would go. There had been

talk of a very inefficient person previously. By what I could learn, they might be prepared to give £1,200 per annum for three years certain, with all kinds of those aids which the Indian Government can so readily afford. There would at the same time be opportunities afforded of obtaining much more insight than we now possess of the geology of India. Copies of your sections and Glamorgan and Carmarthenshire maps have been sent by us, through Dr. Falconer, to the proper parties at the India House, to show your powers, and these have been highly approved. All this is the bright side of the affair. On the other is the tropical climate, with its chances of illness, and that nothing is certain beyond the three or four years—though probably some charge over the coal workings would follow. You see I neither advise for or against. . . .

"Your letter desiring a junction of the Canada Survey with ours I have sent in to our new chief, Lord Lincoln, but have not yet had any remark about it. It certainly might be made useful to all parties.—Ever sincerely yours,

"H. T. De la Beche."

The offer was a tempting one, and at first Logan probably felt inclined to accept it; but, after looking at the matter from every possible point of view, he made up his mind to remain where he was and continue the work already begun. In reply to De la Beche he wrote the following long and interesting letter:—

"Montreal, 12*th*. *May*, 1845.

"My Dear De la Beche,—I have your despatch on Indian affairs, which renders it necessary that I should

inform you of the position of my campaign in Canada.

"At the time I was appealed to to undertake the examination of the Province, a sum of £1,500 had been granted by the Legislature to defray the total probable expense. Of course I was aware that such an amount would be but a drop of what would be required to float me over twenty-five degrees of longitude and ten of latitude. But I undertook the survey, determined to work it out somehow or other, feeling the truth of the saying, 'Where there's a will there's a way.' Fearing that, if a term of years had been insisted on in the first instance, the Government might have been deterred from the undertaking, through an apprehension that they might not be able to get the consent of the Legislature, I said nothing about the matter. But upon being asked what my terms were, I named £500 sterling per annum for myself and £150 per annum for an assistant.

"These terms were considered very reasonable, and were granted. So at once I set to work. The £1,500 I thought might carry me on for two years, by which time I hoped to have had an opportunity to make friends, show the utility of the undertaking, and excite some interest in the subject among the legislators. I soon found that to make any impression it would be necessary to spend more money; that a business office, a museum, a chemist, and a laboratory would be required. At the end of the first year, accident threw in my way a young Pole, who had studied chemistry under Dumas at the École Polytechnique, and brought

good certificates of *capacité* from him. So I took the opportunity to urge the subject upon the Government. But a grand political rumpus had occurred. The French party had got out, and the English party had got in. Uncertain what they would be able to effect in the Legislature, they would give me no official reply, though they did not discourage me privately. On my own responsibility, therefore, I hired a house to serve for an office, museum and laboratory, at £120 per annum; provided chemicals and apparatus at my own expense, and arranged with the chemist for £200 per annum; and at the end of the second year I found that the Survey was about £800 in my debt.

"Avoiding politics as I would poison, I made friends on both sides of the question, and having induced our ministers to take up the matter, I got them to support it so far as £1,500 per annum, including all expenses, for five years. Much to the surprise of my friend the Attorney-General, who took charge of the measure in the House of Assembly, there was not a dissentient voice upon the subject, the only subject of the session in which all agreed. Some of the members considered the sum too little, and £2,000 per annum was mentioned. So I was asked for an estimate of what would be required to place the Survey on an efficient footing. I made out that to pay my assistants at a rate adequate to a vigorous performance of their duties, and to do credit to the Government, on the basis on which I had put the Survey, it would require £1,950 per annum.

"An act was then passed voting £2,000 per annum for five years certain, for the employment of a suitable

number of competent persons, whose duty it shall be, under the direction of the Governor-in-Council, to make an accurate and complete geological survey of the Province, and furnish a full and scientific description of the rocks, soils and minerals, which shall be accompanied with proper maps, diagrams, and drawings, together with a collection of specimens to illustrate the same; which maps, diagrams, drawings and specimens shall be deposited in some suitable place which the Governor-in-Council shall appoint, and shall serve as a Provincial collection. And duplicates of the same, after they have served the purposes of the survey, shall be deposited in such literary and educational institutions of the eastern and western divisions of the Province as by the same authority shall be deemed most advantageous. To defray the expenses of the survey and the arrears of expenditure already incurred, £2,000 per annum are applied for a term not exceeding five years, and I have to report annually in general terms.

"Such is my geological bill—now an act. I drew it up myself, and no changes were made in it. I should have liked very much to leave out the annual report, but I found it would not do, so I must be as cautious on that score as I can. I have recommended and obtained liberal salaries for my assistants. Murray gets £300 sterling per annum; so does my Pole. But, depend upon it, they shall do something for it. Murray works like a galley slave from the time he gets out of bed to the time he returns to it. De Rottermond has not done so much, but he has been in love, and is to get married on the 15th. inst. into a highly respectable

family which has some French political influence. He is a young man, of gentlemanly manners, and, I think, of some energy, though he was completely knocked up in the forest last year, to which I carried him at his own earnest desire, just to show him there was no romance in the matter. . . . I fancy he will do, though, perhaps, he will require some management.

"Many parts of the country are so little known that Murray and I are in some places obliged to add topography to our geology. I wish I could let you see the map of our journey across from the St. Lawrence to Bay Chaleur. The length of our winding line is 111 miles, in which we dialled all the twists and turns of two rivers, one thirty-five miles and the other sixty-five miles, obtaining the bearings of the reaches by prismatic compass and the distances by Rochon's micrometer, and registering at the same time the quality, contents and attitude of every bed of rock we saw, with barometric heights, &c. The distance between the rivers we triangulated by means of well marked peaks, making it seventeen miles. I think you would say we deserve some credit for it. I have protracted the work on the scale of an inch to a mile. The distance in a straight line is seventy-five miles, and on comparing it with the same as determined by the latitudes and longitudes of its extremes on Bayfield's admirable hydrographical charts, we find that everything, without coaxing, falls into place. The bearings are identical, and there are only nineteen chains of difference between us in the distance. I have ordered three more Rochon's out, and I feel much indebted to Mr. Jordan for having men-

tioned the instrument to me. I think Jones [?] could get other orders for it from this country. If the economic facts of Canadian geology should turn out a negative quantity, the topographical facts may return some of the expense. I have made them available in getting the Survey continued.

"Now comes the application of all this egotism. Perhaps the Canadians are leaning on me for the Survey, and might think it not very handsome if I were to leave the country before the expiration of the five years. I am persuaded, though I say it, who should not say it, they will not find any one to take the trouble I do. It has been hinted to me that in continuing the Survey the Government have been in some degree influenced by the circumstance of finding a person who is a Canadian by birth considered competent to do the work. In the next place (but I do not feel that this weighs with me so much as perhaps it ought to do), I can get back my £800 only by saving on the £2,000 per annum for five years.

"But now comes another consideration, which perhaps weighs most. Just look at Arrowsmith's little map of British North America, dedicated to the Hudson's Bay Company, published in 1842. If you have not got a copy, send for one; the expense won't kill you, and there ought to be one in your Record Office. You will see that Canada comprises but a small part of it. Then examine the great rivers and lakes which water the interior between that American Baltic, Hudson's Bay, and the Pacific Ocean—some of the rivers as great as the St. Lawrence, and some of the lakes nearly as large

as our Canadian internal seas, with a climate as I am informed, gradually improving as you go westward, and becoming delightful on the Pacific. It will become a great country hereafter. But who knows anything of its geology? Well, I have a sort of presentiment that I shall yet, if I live long enough, be employed by the British Government, under the Survey you direct, to examine as much of it as I can, and that I am here in Canada only learning my lesson, as it were, in preparation. How insignificant would be the expense to the British Government in comparison with the advantage that might result, and even the satisfaction of the enlightened curiosity would be cheaply purchased by what it might cost. I have been informed of coal in two parts of it—in the Saskatchewan territory, and in Oregon—in the Saskatchewan on the north branch of the river of that name, at Edmonton House, where it is burnt, and in Oregon near Fort Vancouver. But what the extent of the deposits may be, my informant (Sir George Simpson, the travelling Governor and General Inspector of the Hudson's Bay Company's establishment) was not able to say. They may be important. In Oregon, the value of coal for the supply of steamers protecting and connected with our new Chinese trade will perhaps soon be felt, and it might be an item worthy of the attention of the British Government in any settlement of the Oregon question with the Americans.

"When the British Government gave up the Michigan territory at the end of the last American war, with as little concern as if it had been so much bare granite, I

dare say they were not aware that 12,000 square miles of a coal-field existed in the heart of it—larger than the largest in Britain, though the smallest of those belonging to the United States, which possess another of 55,000 square miles, and a third of 60,000 square miles. Saginaw Bay, on Lake Huron, cuts into the first, and Cleveland, on Lake Erie, is within thirty-six miles of the third, both ready to supply American steamers with fuel on the lakes, while ours on the same waters, in case of war, must depend on wood, or coal expensively transported from Nova Scotia or Cape Breton Island, or across the Atlantic from the United Kingdom.

"Taking all this into consideration, notwithstanding I have requested my brother Edmond, of Edinburgh, who has a friend in the East India direction, to make some inquiry into the matter, I fancy you will see that the chances are that I am tied to Canada. I feel grateful to you, however, for thinking of me, and the offer will do good. I shall not let the light of it lie hid under a bushel, but make it show my Canadian friends that geological investigations are something thought of in other parts of the world, and that if I do not accept pecuniary terms more advantageous than they give, it is because I am not influenced by mercenary motives in serving them.—Yours truly,

"W. E. LOGAN."

Exploration with all its hardships was preferable to the worries and cares to which Logan was subjected when in winter quarters. Once afloat in his birch canoe, or scrambling among his favourite rocks unravelling the mysteries of the past, and cares seemed to vanish.

Having driven from his mind all thought of going to India, he set out from Montreal in the latter part of June to explore the Ottawa. Mr. Murray had again gone to continue the work in Gaspé, but the services of a good topograpical surveyor well acquainted with the country were secured, as at that time the Ottawa had not been surveyed for more than 100 miles above Bytown. The journey was performed in canoes manned by Indians, and extended as far as the head of Lake Temiscamang. It was winter before he got back to Montreal, and shortly after his return he wrote to Mr. Murray as follows:

"MONTREAL, *4th. December*, 1845.

"MY DEAR MURRAY,—A great packet of your letters has been put into my hands by my brother, concluding with one of the 12th. of November. When you wrote the same I was at the head of Lake Temiscamang, and I only got home towards the end of last week. After examining such parts of the Ottawa and various tributaries as had already been surveyed to a distance of about 100 miles above Bytown, I examined and mapped the river about 150 miles further, including Lake Temiscamang, which, varying from half a mile to six miles in breadth, comprehends nearly seventy miles of the distance. The Ottawa, you must recollect, has two sides to it, being sometimes a quarter and sometimes not far from half a mile wide. I have put all the twists and turns down, which I conceive to be equal to nearly 300 miles in a straight line. In addition, I have mapped a tributary called the Mattawa, which is a succession of lakes with two sides also; and I have connected my

map of it with the waters of Lake Nipissing. The distance may be about fifty miles, but will equal one hundred in a straight line. The relative heights of all the various sheets and reaches of quiet water in the whole of the survey have been determined by regular levelling to the one-hundredth part of a foot. The bearings have been taken by a theodolite, and the whole of the map has been carefully protracted in the field on drawing paper as the work went on, on the scale of one mile to an inch. Every sight in levelling, every bearing —sometimes twenty at a station,—every micrometer angle, every reduction of the distance to chains and links, and every line of the protraction has been worked by my own hands. You may think, therefore, that I have been a little busy. I was up every morning at four and five o'clock to rouse my Indians (not one of whom would ever stir unless he had my special command), to be ready for an early breakfast and start. We seldom left our work until we could no longer see distinctly, and it was often one, two and three hours after midnight before my protraction was finished and I could creep into my blanket. I have sent down forty-five boxes of specimens, many of them beautiful fossils, and I think I have fallen upon the Gaspé limestone at the head of Lake Temiscamang. At any rate, I have the same *Pentamerus* we found near Cape Rosier and elsewhere. . . ."

While engaged upon this survey the stratified character of many of the crystalline rocks underlying the fossiliferous formations particularly attracted Logan's attention, and he was also much impressed with the

great beds of crystalline limestone which he found interstratified with some of the gneisses. As we shall see further on, the rocks on Lake Temiscamang (afterwards known as Huronian) were recognized as a distinct group resting upon the gneissic series. The sequence and distribution of the Lower Silurian formations in the Ottawa valley were also ascertained, and large collections of organic remains made both from these rocks and from the Upper Silurian limestones on Lake Temiscamang.

The winter in Montreal was a busy one, for already visitors had begun to haunt the Survey Office, sometimes to see the infant museum, but more frequently to ascertain what the "indications" were in portions of the country in which they were perhaps interested. The material which had been gathered during the previous summer and autumn, both on the Ottawa and in Gaspé, had swelled the collection to quite imposing dimensions, and not only had the specimens to be arranged, but the annual report of progress, maps, and accounts of the year's expenditure, had to be prepared for Government. During the earlier years of the Survey, Logan had no secretary or accountant, and a large and annually increasing amount of drudgery therefore devolved upon him. "I used," he says, "at first to make, with my own hands, four manuscript copies of the Annual Report of Progress, often reaching more than one hundred printed pages—one copy for the Government, one for the House of Assembly, one for the Legislative Council, and one for the printer." All the accounts of the Survey were for years kept by himself, and in the most detailed manner, so that any one might see how every penny of the

public money entrusted to him had been spent. Often it was midnight or even one and two o'clock in the morning before he could leave his office, and eventually it became necessary for him to employ assistance.

Some time in 1846 the museum and offices were moved from No. 40 St. James Street to the building on Little St. James Street, then occupied by the Natural History Society. At the instigation of its President, the late Dr. A. F. Holmes, the Society leased its premises to the Survey for £120 per annum, retaining, however, the use of the rooms on the third floor for its collection of specimens and books. This arrangement was no doubt advantageous for both parties, and without increase of expense certainly afforded greatly improved accommodation for the Government museum and offices.

Not until the middle of May were final instructions received with regard to the field-work of the season of 1846. Now it was to be extended westward to the British shores and islands of Lake Superior, in order to ascertain the general geological structure of the country, and "more particularly the nature and quality of certain mineral veins containing metallic ores, alleged to have been discovered by various parties, to whom licenses of mineralogical exploration had been granted by the Government." Such had been the success of mining operations on the south shore of the lake that much attention was beginning to be drawn to the British side, where similar geological conditions were supposed to prevail; and anxious to encourage mining enterprise in this region, the Canadian Government had determined to grant one "mining location" to each

person holding a license of exploration. In accordance with Logan's advice, each mining location was to be five miles in length, by two in breadth, the length to coincide as nearly as possible with the general direction of the mineral veins. Each party entitled to claim a location was to indicate its position to the Provincial Geologist on his arrival, and to be prepared to point out the general course of the mineral vein which he had discovered. The best direction for the location, however, was to be decided by Logan, and the boundary lines run by a provincial land-surveyor, who was to accompany the expedition. In the event of different parties claiming the same location, it was also left to Logan to decide with regard to priority of discovery, and to put the person really entitled to the location in possession of it. In so far as the geology of the region was concerned, there was much of interest, but the judicial work was most distasteful. It was, however, conscientiously carried out in strict accordance with the wishes and instructions of the Government.

On this occasion Logan's party was larger than usual, and included Mr. Murray, a land-surveyor named McNaughton, and Mr. James Richardson, a new aspirant after geological knowledge, who soon became a most enthusiastic worker for science, and, as is well known, served long and faithfully on the staff of the Survey.

At the time of which we write travelling on Lake Superior was attended with many difficulties. There were no regular steamers to the north coast, and the occasional steamers were not only slow, but liable to long detentions from head-winds and storms. At Sault

Ste. Marie, Logan had to wait for a propeller for Keweenaw from the 11th. until the 19th. of June, but while there occupied himself studying the geology of the neighbourhood. His object in going by way of Keweenaw was to examine the remarkable copper deposits of that region before beginning his investigations on the north shore. Before leaving Sault Ste. Marie, he wrote to his brother:—

"SAULT STE. MARIE, 18*th. June*, 1846.

"MY DEAR JAMES,—My whole party, with myself, arrived here last night by the steamer 'Detroit,' from Detroit, and here we have been waiting, that is to say, some of us (Murray, McNaughton, Master Adamson, Frank, and myself), for an opportunity for Keweenaw Point. One occurs this afternoon at five o'clock, and by it we shall go. The vessel is a propeller, and I am told she has good accommodations, but rather think she is slow. I found all the party at Detroit last Monday week, and everything purchased and prepared for a start for the Sault. . . .

"During my stay in this vicinity, I have made an excursion down the channel to St. Joseph's Island, and have visited several points on the American as well as the British side, with Mr. Hubbard, one of the geological assistants to the late Dr. Houghton. I was glad to get a fair collection of fossils and other specimens, and three boxes have been put into the charge of Mr. Bellenden, addressed to your care. . . .

"In my examination of the stratified rocks met with, I was gratified to recognize the same formations as exist in the vicinity of Montreal, and we had an opportunity

of pointing out to Mr. Hubbard the same black, bituminous shales, which have been so universally mistaken for coal. . . . With the exception of those whose names I have enumerated, our party have proceeded in a schooner belonging to the Hudson's Bay Company to Fort William, there to wait for us. They left the day before yesterday. We cross from Keweenaw to Fort William, whence I shall proceed up to Pigeon River, and there begin my examination. I suspect I shall be there before many are ready to claim their locations.

"Mr. Bellenden has given us quarters, and I feel greatly indebted to him for his kindness and attention. The number of strangers who pass this place give him occupation enough, and he has his house constantly full. There are good enough inns on the American side that save him some trouble, as most of those who come up to Lake Superior looking after mines, even though it may be on the Canadian side, frequent them. I understand about 1,000 visitors of all kinds have come up by the steamers this season already. . . . A steamer is just about to be drawn across the portage on the American side up to Lake Superior. She seems a neat little boat, but I do not know what her accommodations are. She appears to me, however, too small for so big a lake.

"There is nothing very picturesque in the scenery about here, it being rather flat. The sail up the channel among the islands from the Point Detour, which is at the south-west corner of Drummond Island, constitutes the prettiest part of it."

The copper mines of Keweenaw peninsula astonished Logan not a little. "I have come to the conclusion," he writes from Copper Harbour, "that there is much more copper in the country than I had any notion of. There is scarcely a vein which does not contain indications of the metal, however small the vein may be, and I have been surprised to observe what small indications have led to great results. The quantity of silver associated with the copper is more than I anticipated. . . . The largest mass of copper I have seen would weigh about eleven tons, and contains about forty-five cubic feet. . . . I am waiting for a vessel to carry me across the lake."

The vessel was little more than a barge, and so laden with cargo that some of the passengers had to sleep on deck. Logan's camp equipage was spread over some of the barrels in the hold, and upon this he endeavoured to sleep; but, owing to a substratum of pots and pans, found it rather uncomfortable. On reaching *terra firma* he again wrote to his brother:—

"PRINCE'S HARBOUR, LAKE SUPERIOR, 22*nd. July*, 1846.

"MY DEAR JAMES,—I have got to this side, and have commenced my examination. That copper exists there is no doubt—how much of it remains to be proved. . . . While McNaughton measures, I examine the geology of the vicinity, and have been most kindly assisted by the gentlemen in charge of the Colonel's interests. . . . There is good copper ore (grey sulphuret) on Prince's location. The vein in which it occurs is composed of calc-spar, barytes, and amethystine quartz, and is altogether about fifteen feet wide, while the metalliferous

portion appears to be about four feet eight inches. If all the spar-veins are like his, there will be little doubt of this becoming a copper region; but I have not yet heard of any strong cupriferous indications having been discovered in the other spar-veins of the vicinity. . . .

"The scenery here is very beautiful. Lofty cliffs guard the whole coast. They are vertical for some distance at the summit, and then slope down at an angle of 45°, making a talus to the water's edge. . . . Multitudes of beautiful harbours exist on the coast, scarcely a couple of miles occurring without one, and there is deep water in most of them. I understand an American steamboat is to make two tours of the British side during the year. She will have no difficulty in finding shelter wherever she goes, should she be overtaken by a storm."

From Fort William a "geological communication" of sixteen closely-written pages, was addressed to Lord Cathcart, the Governor-General of Canada.* "My Lord," it begins, "I take the opportunity afforded me by Sir George Simpson's passage through this on his journey from Red River to Montreal, to do myself the honour of addressing a few lines to your Lordship, not for the purpose of communicating any official

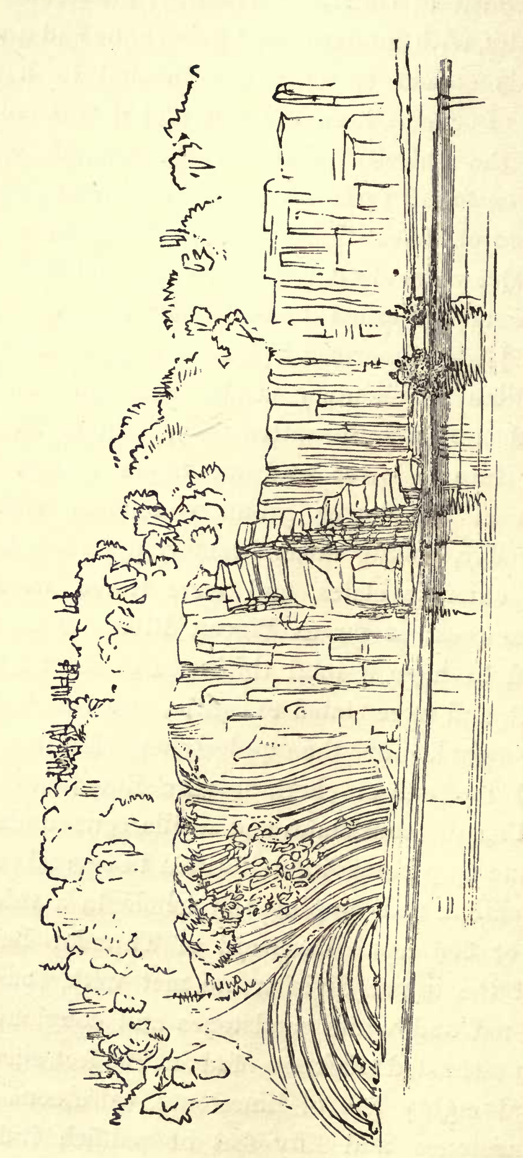
* When the illness of Lord Metcalfe compelled him to resign the Governorship of Canada and return to England, in 1845, he was succeeded by Lord Cathcart, who was at that time acting as Commander-in-Chief of the troops in British North America. Lord Cathcart had long been an ardent student of geology and mineralogy, and in 1841 (then Lord Greenock), first recognized as a distinct species the mineral which was named Greenockite in his honour. During his residence in Canada he took a lively interest in the geology of the country, and gave Logan much encouragement in his work.

intelligence with regard to the investigation with which I am charged (which it would scarcely be expedient to do until my examination has been extended over a greater surface); but simply to state some of the geological facts up to this time observed, as I would to any other eminent member of the Geological Society."

Then follows a description of the regions visited on the south and north shores of the lake. "The age of the rocks on the south side is," he says, "yet a disputed point. Some geologists are disposed to consider them contemporaneous with the New Red Sandstone—for what reason I am unable to ascertain; for the mere mineral fact of the presence of trap associated with red sandstones would, in my opinion, be no reason at all. The late Mr. Douglas Houghton, the Michigan State Geologist, who was undoubtedly a careful and accurate observer, and had devoted many years to the examination of the country, places the rocks at the very base of the stratified series. Perhaps the horizon may be intermediate between the positions assigned."

The rocks on the north shore of Lake Superior, whose investigation Logan began in 1846, have, like those on the south, been the subject of much discussion among geologists, and even at the present day conflicting opinions are entertained with regard to them. A brief statement, more especially of Logan's views of the subject, is therefore called for here. According to his first report on the region, published in 1847, the most ancient rocks met with on the north shore of the lake consist of granite and syenitic granite, "which appear to pass gradually into gneiss." Overlying this came

a series stated to consist of chloritic, micaceous, and talcose slates, with interstratified greenstone and quartz-rock. This second series was estimated to have a thickness of several thousand feet, and it was pointed out that the chloritic slates at the summit would probably be found to be identical with those seen the year before on Lake Temiscamang. These two series were in later years classed as Laurentian and Huronian. To the second succeeded the so-called "Volcanic formations" of Logan, described in his report as consisting of uncrystalline sedimentary strata, both interstratified with and capped by eruptive rocks, and regarded as divisible into a lower and an upper group. The members of the lower group were met with on Thunder Bay, resting unconformably upon the highly inclined chloritic slates, and were traced westward along the coast as far as Pigeon River. They were estimated to have a total thickness of from 1,500 to 2,000 feet, and were stated to consist of a conglomerate holding pebbles of the underlying chloritic slate, followed by beds of chert, impure limestones, dark-coloured argillaceous slates and argillaceous sandstones, crystalline trap being interstratified in several parts of the formation, and capping the whole to a thickness of 200 or 300 feet. Eastward of Thunder Bay, the rocks of the upper division are met with, consisting first of red and white sandstones and conglomerates, with an estimated thickness of about 700 feet, succeeded by about eighty feet of limestones, calcareous shales and sandstones, and fifty feet of reddish indurated marls. "After an interval of which the amount is



COLUMNAR TRAP IN LOGAN'S UPPER COPPER-BEARING SERIES.

Note Book, 1846.

uncertain," came other sandstones and conglomerates (supposed to be younger than the reddish marls), interstratified with amygdaloidal and compact "trap," and crowned by "an enormous amount of volcanic overflow." The total thickness of this upper group Logan estimated roughly at from 6,000 to 10,000 feet, but a much greater thickness has since been assigned to it. In many places it is rich in native copper, and Logan regarded it as identical with the similar cupriferous series of the south shore and of Isle Royale—a view which Whitney and other geologists afterwards concurred in. Logan also looked upon his "Volcanic series" as more ancient than the horizontal palæozoic sandstones of Sault Ste. Marie, concerning which we shall speak presently.

The explorations carried on by the Survey during the next few years, on the north shore of Lake Huron, showed the existence there of a great series (often containing sulphuretted copper ores) of chloritic slates, conglomerates, "greenstones," quartzites, and limestones. Notwithstanding the similarity of many of these rocks to those seen on Lake Temiscamang in 1845, and again beneath the "Volcanic series" of Lake Superior in 1846, they were for a time regarded by Logan as identical with the latter, and in his report for 1848, page 20, he says: "The chief differences in the copper-bearing rocks of Lakes Huron and Superior seem to lie in the great amount of amygdaloidal trap present among the latter, and of white quartz-rock or sandstone among the former. But on the Canadian side of Lake Superior there are some considerable areas,

in which important masses of interstratified greenstone exist without amygdaloid, while white sandstones are present in others. . . . But notwithstanding these differences, there are such strong points of resemblance in the interstratification of igneous rocks, and the general mineralized condition of the whole, as to render their positive or proximate equivalence highly probable, if not almost certain."

When the *Geology of Canada* was published in 1863, the "Volcanic formations" of Lake Superior appeared under the name of the Upper Copper-bearing series, to distinguish them from the Lower Copper-bearing rocks (the Huronian), which were now recognized as more ancient strata. As before, the series was divided into a lower and an upper group, the whole being still regarded as older than the horizontal sandstone of Sault Ste. Marie, which was referred to the Chazy formation (*Geol. of Can.*, 1863, p. 86). Furthermore, it was stated that if this were the true horizon of the horizontal sandstone, then "the copper-bearing portions of the Lake Superior rocks might reasonably be considered to belong to the Calciferous and Potsdam formations." (*Geol. of Can.*, 1863, p. 86.) In the same volume (p. 236) it was suggested that the Upper Copper-bearing series of Lake Superior and the Quebec group belong to the same geological horizon; and in accordance with this view we find that in the geological atlas published in 1864, as well as on the large geological map which appeared some time later, the former series is represented as belonging to the Quebec group. On the same maps the Sault Ste. Marie sandstones were

coloured as Chazy. Later observations seem to show that they are Potsdam rather than Chazy in age. This was the opinion long ago held by Whitney, who, however, maintained that the sandstone and the Upper Copper-bearing series of Logan belonged to one and the same formation.

The view that the rocks of Logan's Upper Copper-bearing series are wholly or in part of Mesozoic age can only be briefly alluded to here. It was years ago held by Charles T. Jackson and Marcou, and has since been advocated by several other geologists, including Mr. Thomas Macfarlane and Dr. Robert Bell. Macfarlane discussed the question in an interesting paper, or rather series of papers, on the Geological Formations of Lake Superior, published in the *Canadian Naturalist*, in 1868. Bell again called attention to the matter in the report of the Geological Survey for 1866-69 (p. 321), pointing out the lithological resemblances of the series to rocks of Mesozoic age in Nova Scotia; but in a postscript to the same volume Logan expressed his dissent from Bell's views, giving at the same time reasons for adhering to the opinions which he had previously expressed on the subject.

In the report of the Survey for 1872-3 (p. 106), Bell suggested that "if it were found desirable to give a shorter name to the rocks of the Upper Copper-bearing series of Lake Superior," it might be termed the Nipigon series. A short time before, however, Dr. Hunt had proposed that the lower division of the series should be distinguished as the Animikie group (from the Indian name for Thunder Bay), and had also suggested that

the "great series of highly-inclined sandstones and conglomerates, which, with interstratified trappean masses, constitute the cupriferous formation of this region," should be known as the Keweenaw group—or, as he subsequently put it, Keweenian.* In May, 1873, he further proposed that the name Nipigon Series should be adopted for the red sandstones and marls overlying his Animikie group, and which Logan had placed at the base of the upper division of his Upper Copper-bearing series. Hunt also concludes that his Animikie and Nipigon groups constitute two distinct series of rocks, both younger than the Keweenian. "The lithological characters of the Nipigon group," he writes, "are, moreover, very distinct from the Cambrian sandstones found at Sault Ste. Marie, and along the southern shore of Lake Superior, with which it was formerly confounded, and it will probably be found to belong to a more recent period; so that while the Keweenian series is pre-Cambrian, the Nipigon, and also the Animikie group, may be post-Cambrian and perhaps Mesozoic."†

From the foregoing statements with regard to Lake Superior geology, it may be thought by some that the natural confusion of the rocks has been "worse confounded" by the "many men of many minds" who have held such diverse opinions and given us so many names to learn. It is to be hoped, however, that the

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* Trans. Am. Inst. of Mining Engineers, I., 339. Also, Azoic Rocks, pp. 231, 240.

† Azoic Rocks, p. 241. Many of the facts given above concerning the geology of Lake Superior are from this valuable work, to which the reader is referred for fuller information.

matter will be simplified by the following table of the series of rocks recognized on the north shore of the lake :—

I. Laurentian.

II. Huronian or Lower Copper-bearing series.

III. Volcanic or Upper Copper-bearing series of Logan, termed Nipigon series by Bell ; older than the sandstones of Sault St. Marie, according to Logan ; Mesozoic of some geologists ; partly pre-Cambrian and partly post-Cambrian, according to Hunt ; divided by Logan into a lower and an upper group, the relations of which to Hunt's groups are as follows :

Logan.	*Hunt.*	
a. Lower group...........	Animikie group.	Post-Cambrian and possibly Mesozoic.
b. Upper group........	Nipigon group..	
	Keweenian (or true copper-bearing) group.	Pre-Cambrian.

IV. Palæozoic sandstones of Sault Ste. Marie, referred to the Chazy by Logan, but probably of Potsdam age.

CHAPTER XII.

EVENTS OF 1846–53.

EARLY in 1846, Mr. De Rottermond, the chemist and mineralogist to the Canadian Survey, resigned his position, stating that this step was rendered necessary by urgent family affairs. Notwithstanding his certificates of *capacité*, he had proved to be unfitted for the post, and his voluntary resignation was doubtless a great relief to Logan. It was not long, however, before he applied to the Government to be reinstated, but with the condition that he should not be subject to the control of Mr. Logan. The Survey, he maintained, should consist of two separate and distinct departments —a geological and a chemical—with a director for each. Logan might be the head of the geological branch, but he should be king of the chemical. Such was the scheme proposed; but it is needless to say that it did not meet with the approval of the Government.

In order that all the facts connected with Mr. De Rottermond's resignation might be known to the Government, a lengthy statement was prepared by

Logan; and in this he refers in an amusing and characteristic way to the division of the Survey proposed by the late chemical assistant. "Without any further reference," says the document, "to Mr De Rottermond, if I might be permitted to express an opinion on the subject of a separation of the chemical from the other departments of the Geological Survey, it appears to me it would be found to work very ill. I understand the plea upon which it has been proposed is that if the geologist were to ascertain localities and collect materials, and the chemist to determine what the materials contained, each rendering a separate report to the Government, the Government would then have the localities, the materials and their constituents, while the geologist, not knowing the exact constituents, and therefore the exact value of the materials, would not be tempted to turn his knowledge of localities to his own private advantage; while the chemist, not aware of the localities, could not make available his knowledge of values for the peculiar benefit either of himself or his friends. This suggestion seems to proceed upon the principle that the geologist and the chemist may be a couple of rogues, such as would deserve to be expelled from all decent society, and that the rule of government should be division and mistrust.

"A dishonest geologist, however, could do more mischief than a chemist of the same stamp. The geologist could with facility conceal his knowledge of localities, retain materials in his own possession, and get them analyzed privately for his own purposes. Neither the Government nor the chemist could easily detect his

manœuvre, and to come at his concealed facts, if he were suspected, it would be necessary to institute an expensive examination, in fact to do his field-work over again; and if any material were discovered which he had not reported, who could say whether it had been missed by inadvertance or not? What could the dishonest chemist achieve? He dare not either conceal or falsify his analyses. The Government or the geologist might, at a small expense, have an analysis of the material performed by another party; and not knowing localities, he could not avail himself of them for his own advantage. But, after all, it would be necessary to bring the materials in regard to locations, quantities and uses before the public, for whose benefit the search for them had been instituted, and then a third party would be required to combine the work of the geologist and the chemist, which third person would in reality be the head, and if he were destitute of proper principle, as the other two are supposed to be, he could with equal facility abuse his trust, by giving early intimation to his friends, or getting them to act in his own behalf. Who would be a check upon him?

"No honest man would, in my opinion, humiliate himself so far as to accept of employment under such a pitiful system, and no efficiency could be the result. Good government requires that confidence should be reposed somewhere in every department, and the great art is to select such persons as, from their skill and character, shall be entitled to such confidence. A geological survey is no more than any other work to be performed. To be conducted efficiently it must have a

head to arrange, direct, concentrate, and generalize in all the accessories. Chemical analysis is one of them. Geology includes it, and not it geology, and it is only a person profoundly ignorant of the science that could suppose otherwise. It is the geologist who knows how many chemical facts he wants, not the chemist how many he should give. The chemist should, therefore, be the assistant of the geologist, and it is desirable that he be an assistant in whom he can place reliance."

Not long after this, Mr. Denison Olmsted, Jr., son of Professor Olmsted of Yale College, received the appointment of chemist to the Canadian Survey. Owing to ill health, however, he was unable to assume the duties of the office, and his early death, in the autumn of 1846, once more left the post vacant. It was then offered to Mr. Thomas Sterry Hunt, who at the time held a similar position under Professor C. B. Adams of the Geological Survey of Vermont, and who, although only twenty years of age, had already given ample evidence of more than ordinary ability, while acting in the capacity of chemical assistant to the late Professor Silliman, in the laboratory of Yale College. In December, 1846, his appointment as chemist and mineralogist to the Canadian Survey was confirmed, and in the following February he came to Montreal and began the series of investigations which were destined ere long to give him a world-wide reputation, and to add so greatly to the *éclat* of the Geological Survey.

Almost every succeeding summer found Logan at work in some new region. In 1847, during the season

suitable for the field, his attention was engaged with an examination of the country on the south side of the St. Lawrence, extending from the vicinity of Montreal and Lake Champlain to the River Chaudière, and here he was accompanied for part of the time by Mr. Hunt, Mr. Murray having gone to explore the northern shores of Lake Huron. It will be observed that the region in question comprises part of the so-called Eastern Townships, whose complex geology Logan afterwards so faithfully strove to elucidate. In 1840, as we have already seen, he had passed through "the Townships," on his way to the State of Maine, and his attention had then been attracted to the serpentines and other rocks in the "metamorphic" region. Nor did he early fail to appreciate the fact that there were difficult problems for the geologist to solve. Writing from Boston to his brother James, on the 16th. of December, 1842, he says: "I arrived here with my two companions last evening, about 7 o'clock, after a very comfortable journey, in sleighs as far as Concord, and the remainder of the way by rail. I could not geologize much on the road, in consequence of the snow, but still I obtained a hint or two. They were hints, however, which perplexed me, rather than cleared up difficulties. I had expected that in crossing the Green Mountains some light for the benefit of the Eastern Townships would have emanated from the rocks, but I only got evidence of the necessity of great caution in the examination of that part of Canada." This caution he never ceased to observe, and in his intense desire to first amass every possible fact

concerning the much-perplexing strata, he refrained from publishing many valuable results of long and arduous labour and thought.

When the spring of 1848 came round, he again proceeded to the Eastern Townships in order to further prosecute the investigations of the previous year. But scarce had two months elapsed when he was once more obliged to turn his steps westward; this time to the northern shores of Lake Huron, whither Mr. Murray had already preceded him. Several mining locations in this region had been claimed from the Government, and considerable sums of money expended by the persons interested in them; so that it seemed advisable that something should be done on the part of the Government towards examining the country geologically, and ascertaining the probable productiveness of some of the principal metalliferous veins. There was no man in Canada better qualified than Logan to judge of the value of metalliferous deposits, and particularly those of copper. While residing in Wales he had had every opportunity of familiarizing himself with the various ores of copper, and the methods of sampling them, and the information then acquired now proved of great value to him in the examination of the Bruce Mines. His report upon these mines, which was published by the Government, is an excellent example of the thoroughness, carefulness, and practical character of his work. But in addition to his detailed examination of the location containing the Bruce Mines, he, with the assistance of Mr. Murray, made an accurate topographical and geological survey of the Thessalon

River for twenty-five miles from its mouth, of the Missisagui for nearly forty miles from its mouth, and also of a number of lakes and minor streams. Besides this, the coast of Lake Huron itself was examined for a distance of seventy miles, and numerous excursions made for short distances inland. All this occupied less than three months, and then he left the rocky shores and islands of Lake Huron, never to return to them again.

While engaged in his survey of the Bruce Mining locations, an incident occurred which well illustrates how completely he sometimes became absorbed with any interesting geological question which he happened to be investigating. We give it in the words of his friend, Mr. Alexander Murray :—

"One day, after some very fatiguing work, as I was about to retire for the night, Mr. Logan was not to be found. Darkness was fast approaching, and although I made most diligent inquiry at the mine, no one could give any information further than that when last seen, several hours previously, he was superintending the drilling operations. Naturally a good deal of alarm was felt for his safety, but how or where any accident could have befallen him, no one could conjecture, and to search the woods on a pitch dark night was simply impossible. However, it was considered that should he by any chance have lost his way, the blasts which were being discharged at short intervals at the mine would surely be a guide to him as to the direction in which to proceed homewards. About midnight a fearful thunderstorm came on, with torrents of rain. The hours passed, and morning dawned; but still no signs of Mr.

Logan, and now we were all thoroughly alarmed. A search through the woods was resolved upon forthwith, when suddenly, a little after day had fairly broken, he was perceived emerging from the bush, hammer in hand, occasionally pounding a rock as he advanced, and seemingly quite unconcerned, though his trousers were torn to rags, and his boots completely minus the soles! On asking him how he got through the night, he answered with the greatest *sangfroid*, 'Very well.' He had left the mine to learn the sectional structure of the rocks, by keeping a course across the line of strike through the woods, and wandered on, intent upon his subject, till night overtaking him, he felt it would be impossible to scramble back, and at once set to work to bivouac where he was. He selected a huge boulder, which slightly overhung in the opposite direction to the wind, and having by accident a couple of matches in his pocket, he managed to start a fire; but having no axe, was unable to lay in a stock of wood. He passed the night reclining against his boulder, which in some degree sheltered him from the falling rain, but before morning his fire was drowned out, and he found himself almost surrounded by a pool of water. He had not a morsel of anything to eat, and as he never smoked, there was no creature comfort to sustain him; but he was perfectly consoled by philosophically reflecting that he had ascertained a few geological facts which might be turned to good account as further investigations proceeded."

Returning from Lake Huron to the Eastern Townships, he remained in the field until the severity of the

weather drove him into winter quarters; but with the return of spring he was again to be found at work in the region between the Chaudière River and the Temiscouata Portage Road. Not long before this some of the inhabitants of the vicinity of Baie St. Paul, below Quebec, had announced the discovery of what they stated to be indications of the existence of coal in that region, and had even induced the member for Saguenay County to apply to the Legislature for means to carry on boring operations in search of the supposed coal-seams. But the Government naturally objected to granting the money unless it could be shown that there was some ground for expecting useful results, and Logan was instructed to visit and examine the locality. The newest rocks in the region belong to the Trenton formation, and neither in these, nor in those beneath them, was there the slightest probability of the existence of coal. But the professed discoverers of the substance had somehow got it into their heads that the presence of coal-seams in any region was usually indicated by fragments being carried to the surface by springs of water, and having carefully *packed* numbers of springs with pieces of imported coal, they easily convinced the more credulous inhabitants that untold wealth lay beneath them.

The fraud and absurdity of the whole thing must have been evident to Logan from the first, and he might have dismissed the matter as a farce. But to those ignorant of the principles of geology this would have seemed arbitrary dealing, and, besides, he had been instructed by Government to report upon the

locality. Accordingly he drew up a report, in which he discussed the matter fully, giving all the scientific reasons against the occurence of coal, and finally stating pretty plainly his belief that the fragments had been placed in the springs for a purpose.

This, however, was not the only case in which he had to oppose, or rather expose, the would-be discoverers of coal. In the very first year of the Geological Survey an act was passed establishing the "Gaspé Coal and Fishing Company." Its members, who were chiefly persons in England, had been induced to believe in the probable existence of coal in Gaspé, and were on the eve of paying down several thousand pounds for a property stated to contain coal; but owing to the adverse opinions of Logan having come to their ears, the conditions of purchase were altered, and it was stipulated that the money should be paid down when the coal was actually found, and not before. Subsequently miners were sent out from England, but history does not tell us that they succeeded in finding the coveted fuel; and it may be concluded that the purchase money was never paid.

At another time it was announced that a real *practical miner* had discovered coal on the farm of a Mr. B——, near Bowmanville, in Upper Canada. The said Mr. B—— was easily persuaded that boring operations should be undertaken, and forthwith supplied bore-rods and tools to test the ground. Sections of the strata stated to have been passed through were duly heralded in many of the newspapers; representing alternations of sandstone shale and *coal-seams* as well-

ascertained facts. Great was the excitement occasioned by the wonderful discovery, and intense the indignation expressed against the unfortunate geologists whose fine theories had been so ably contradicted by the experience of a practical working-man. This time, however, Logan declared from the first that there was no coal there, and refused to so much as visit the place, knowing well from the previous explorations of Mr. Murray what the geology of the region was. About the time that the excitement was at its height, it happened that a great friend of Logan's, the late Sheriff W. B. J——, being on his way to Montreal, stopped at Bowmanville for the express purpose of satisfying himself with regard to the various statements which he had seen in the newspapers as to the discovery of coal there. The spot was visited, and with his own eyes he saw the bore-rod lowered, and fragments of coal extracted from the hole. This was enough for the Sheriff, and as soon as he reached Montreal he hastened to the Survey Museum with his much-prized specimens, and, placing a black fragment in Logan's hand, enquired, "What do you call that?" "A good bit of Newcastle coal," was the reply. "I saw it taken out of the bore-hole at Bowmanville with my own eyes," said the Sheriff. "Ah," replied Logan, with his most waggish look, "You should have been there sooner, and looked more sharply, and then you might have seen it put in." The possibility of such a proceeding had never occurred to the worthy Sheriff; but not long afterwards, while some other visitors were witnessing the extraction of coal from the same bore-hole, they

observed that the coal was mixed with bread and cheese, which had accidentally got into the hole during the preliminary packing operation. This put an end to the Bowmanville excitement. Eventually it turned out that the bore-rod had never reached the solid rock at all, but had simply passed through a portion of the superficial deposits.

The Provincial act which had been passed in 1845 made provision for the continuance of the Geological Survey for five years only, and of course Logan could not tell what would be done by the Government at the expiration of this period. It seemed unlikely that his Survey would be suddenly terminated when so much still remained to be done; but at the same time he felt that no harm could result from his going to Toronto, then the seat of Government, and in person urging the claims of his work. While in Toronto he wrote to his brother:—

"TORONTO, 13*th. February*, 1850.

"MY DEAR JAMES,—Supposing that my affairs were arranged here, it was my design to have started on my return this morning; but having been informed that there is an intention on the part of the Government to continue the Survey, though the details of the continuation have not been arranged, I have deemed it prudent to remain a day or two longer, lest being out of sight, I should get out of mind. . . .

"I think most of the gentlemen of the Council are in favour of continuing the Survey on the present footing, with the exception of Mr. M——, who, I dare say, would like to stop it altogether; or, if not able to do

this, to reduce the allowance. I have informed him that I, individually, will not work for less than I get; that the only reduction that could possibly be effected would be in the number of hands employed; that I cannot do without Mr. Hunt, particularly as an examination of the soils of the country constitutes a branch of the subject contemplated by the act of the Legislature, and one in which the services of a chemist are indispensable; and that if I were deprived of Mr. Murray (whose duties are of a nature similar to my own, and who is competent to explore separately), the Survey would take nearly twice the time that it would with him.

"Mr. C—— intends to oppose the Government, I believe, on the score of retrenchment; but he has informed me that he does not mean to attack the Survey, as he considers the investigation with which it is connected a proper and necessary one. I by chance met Sir Allan McNabb on the street, and informing him that I was here on the subject of the continuance of the Survey, he remarked that it ought not to have been begun if it were not to be finished. So that I think the Government would not meet with any opposition in respect to the matter, except from such men as are of M——'s frame of mind. There may be some of these among the *Clear Grits*, as they are called; but I think that, upon the whole, of the opponents to the Government, more would find fault with the abandoning of the Survey than with the carrying it on."

The act was finally renewed, with the same provision as for the preceding period of five years, but not until

the long delay had interfered considerably with the regular work of the Survey. It was also decided by the Government that a collection of Canadian economic minerals should be prepared and forwarded to the "Exhibition of the Industry of all Nations," to be held in London in the following year. This, it will be remembered, was the first of the great International Exhibitions, and originated with His Royal Highness Prince Albert, who himself acted as President of the Commission appointed to conduct the exhibition, and to whom a medal was awarded "for the conception and successful prosecution of the idea."* During the summer of 1850, a large collection of the economic minerals of Canada was obtained by Logan and his staff, and after being displayed at a Provincial Exhibition in Montreal, was forwarded to London. Leave of absence was also given to Logan, in order that he might superintend the arrangement of the collection; but, although his salary was continued during his absence, he was allowed the privilege of paying all his own expenses, amounting to £450. Sailing from Boston on the 15th. of January, after a stormy voyage, he arrived at Liverpool on the 27th. The exhibition building at London was not quite ready, so that he had an opportunity of visiting his brother Edmond, at Edinburgh, and his sister, Mrs. Gower, at Castle Malgwyn, in South Wales.

It was eight years since he had been in England, and we can readily imagine what pleasure he must

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* Prince Albert exhibited a number of articles, including wool from the Cashmere goats kept at Windsor, wheat, beans, and oats, a model of a dwelling-house, &c.

have felt at again seeing his brothers and sisters, and recounting to them his adventures by land and stream in Canada. During these eight years, too, his work had been carried on almost alone, and now how intense must have been the satisfaction of meeting with so many brother scientists, and describing to them the geological wonders which this period of unceasing toil had revealed to him. De la Beche, Murchison, Lyell, Ansted, Bigsby, and many others, he no doubt met at the reunions of the Geological Society, or at Jermyn Street; and Hugh Miller he visited in his own home, in Scotland. He was also present at the meeting of the British Association at Ipswich, in July, and there read a paper entitled: "On the Age of the Copper-bearing Rocks of Lakes Superior and Huron, and various facts relating to the Physical Structure of Canada."

The exhibition was formally opened on the 1st. of May, and it was only by the most strenuous exertions that Logan succeeded in getting his department in readiness. On the 2nd. of May he wrote to his brother James: "The Exhibition opened yesterday in grand style, and I am almost knocked up with the exertions I have been obliged to make to be ready in time. I have worked from 6 a.m. to 8 p.m. for some time back, and the last three days never breakfasted until nine o'clock at night. Our Canadian department looks remarkably well, and is generally spoken of as very creditable. I have been appointed a juror to determine prizes in the Mineralogical and Metallurgical department. There are eight jurors in that division, Sir H. T. De la Beche being the Chairman."

Among the other members of the Jury in Class I. were Professor Faraday of the Royal Institution, Professor Tunner, President of the Imperial Mining School at Leoben, in Styria, and A. Dufrenoy, then Inspector General of Mines in France. Dufrenoy acted in the capacity of *Deputy-Chairman and Reporter*, and from his valuable report (p. 2) we take the following:—

"Before commencing the detailed description of objects which have obtained medals or honourable mention, we feel bound to mention also the interesting collection from Canada, procured by Mr. Logan, Director of the Geological Survey of that colony, and a series of copper ores, with model of a mechanical preparation of working these ores, exhibited by Mr. Richard Taylor, Mineral Surveyor of the Duchy of Cornwall. These two gentlemen, being both of them members of the Jury, they, as well as the Chairman, Sir H. De la Beche, are of necessity excluded from receiving honorary awards in this class.

"The collection from Canada is accompanied by a geological map, which will, we hope, be very soon published. . . .

"Of all the British Colonies, Canada is that whose exhibition is the most interesting and the most complete; and one may even say that it is superior, so far as the mineral kingdom is concerned, to all countries that have forwarded their products to the exhibition. This arises from the fact that the collection has been made in a systematic manner, and it results that the study of it furnishes the means of appreciating at once the geological structure and the mineral resources of

Canada. It is to MR. W. E. LOGAN, one of the members of the Jury, who fills the office of Geological Surveyor of Canada, that we are indebted for this collection; and its value arises from the fact that he has selected on the spot most of the specimens that have been sent to the Exhibition, and has arranged them since their arrival in London. . . ."

While in London at this time, Logan was elected a Fellow of the Royal Society, his name having been proposed by Sir Roderick Murchison. The honour seems to have been most gratifying to him, particularly as he was "the first native Canadian elected for work done in Canada."

At the close of the Exhibition he received the following graceful recognition of his services from Prince Albert:—

"WINDSOR CASTLE, *October* 31*st.*, 1851.

"SIR,—I have the honour, as President of the Royal Commission for the Exhibition of 1851, to transmit to you a Medal that has been struck by order of the Commissioners, in commemoration of the valuable services which you have rendered to the Exhibition, in common with so many eminent men of all countries, in your capacity of Juror.

"In requesting your acceptance of this slight token on our part of the sense entertained by us of the benefit which has resulted to the interests of the Exhibition from your having undertaken that laborious office, and from the zeal and ability displayed by you in connection with it, it affords me much pleasure to avail myself of this opportunity of conveying to you the

expression of my cordial thanks for the assistance which you have given us in carrying this great undertaking to its successful issue.—I have the honour to be, sir, very faithfully yours,

"(Signed) ALBERT,

"President of the Royal Commission.

"*W. E. Logan, Esq., F. R. S.*"

Several times Her Majesty and the Prince Consort visited the Canadian division of the Exhibition, and once or twice Mr. Logan had the honour of receiving them; but, much to his annoyance, he was absent on the other occasions. In a letter to his brother James, written on the 8th. of May, he says:—

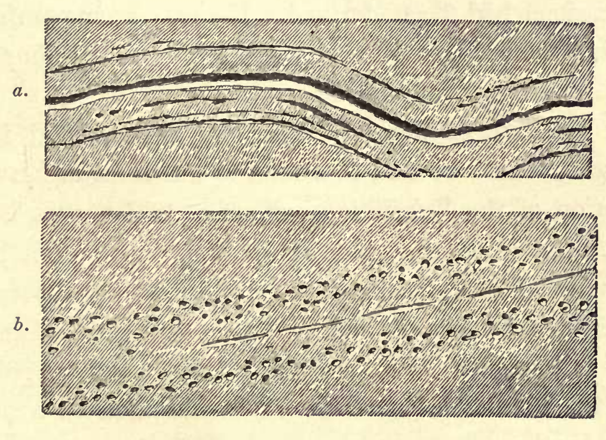
"Her Majesty has been through our division more than once. She and Prince Albert passed through yesterday morning. They were rather early, and I was not there—not expecting them before Saturday. But a particular friend of mine, Dr. Lyon Playfair, accompanied the Royal party, and explained many things; and Perry, the fire-engine builder, did his best to explain others. The fire-engine attracted particular attention. Prince Albert assisted Perry with his own hands to take it to pieces, in order that it might be thoroughly comprehended, and was greatly interested in it. The chairs sent home for Her Majesty are rather conspicuously displayed, and are labelled 'FOR ENGLAND'S QUEEN, FROM THE LADIES OF CANADA.' The label attracted Her Majesty's attention. No doubt she had never heard of the chairs before, and she turned to Col. Grey, who was with her, and asked if the label were correct. He informed Her Majesty that

it was, and that the chairs had been officially acknowledged. I understand Her Majesty rather smiled, and no wonder; for, in my opinion, they are not very grand. Only think of their being adorned with yellow worsted fringe. In the notice of them in one of the newspapers, some one has said that they are supposed to have been made in imitation of chairs carried to Canada by Sebastian Cabot; and my good friend Mr. Houghton, who as agent of the Commission is very zealous, and has taken a great deal of trouble, has had the simplicity to send a letter to the paper, contradicting the supposition. When Her Majesty smiled, Perry had the presence of mind to say that the furniture sent from Canada was not intended to compete in art with the manufacture of England, but to show our black walnut, so well adapted for ornamental purposes, and that if Her Majesty, and the English nobility and gentry, would patronize the wood, it might become an article of extensive commerce. Her Majesty said that the *wood* was a very beautiful one."

Logan had hoped to return to Canada in May, in order to resume his geological work there; but in this he was disappointed, his duties as Juror making it impossible for him to leave before the month of August. But his stay in London was probably productive of even greater good for Canada than his return would have been; for he lost no opportunity of drawing attention to the resources of the country, and succeeded in diffusing much valuable information, and in uprooting some of the erroneous ideas concerning Canada which prevailed in the minds of many. He was not a

little annoyed by some of the statements which found their way into the British newspapers. One brilliant correspondent, for example, published an article on the sperm-whale fisheries of Canada, evidently based upon the fact that the jaw of one of these whales—from Hobart Town, Van Dieman's Land—happened to lean against some Canadian timber at the Exhibition. The same writer also described the yellow gum-tree as one of the indigenous trees of Canada.

When Logan went to London in the winter of 1851, he carried with him the plaster cast of a curious fossil track from the Potsdam sandstone of Beauharnois.



TRACKS FROM BEAUHARNOIS. SCALE, 1/10.

(*a.*) *Protichnites lineatus* (Owen).

(*b.*) *Protichnites octonotatus* (Owen).

"*Geology of Canada,*" p. 104.

His attention had been drawn to the track by Mr. Abraham, then editor of the Montreal *Gazette*, who had noticed it in his journal, and compared it to the track of a tortoise. From the inspection of the cast, Owen was

also disposed at first to believe in the chelonian origin of the footprints, and the discovery created no small stir among the British geologists, who were not prepared to hear of vertebrate life so far back in geological time. Murchison, however, was skeptical from the first. "If," he wrote to Lyell, "if Logan had found the print of an aldermanic Robinson Crusoe's foot, as he was intent on realizing the first turtle-soup, then I would knock under."* But turtle or no turtle, the tracks were of great interest, and on his return to Canada, in August, Logan devoted several months to the study of the Potsdam sandstones from which the impressions had been derived. He was accompanied by Mr. Richardson, who was successful in finding a number of other valuable specimens.

On the 6th. of January, 1852, he again sailed for England, where he had to attend to the distribution of a portion of the Exhibition collection which was left there. This was the chief object of his visit; but he took with him a large collection of the newly-discovered tracks—both originals and casts—in order to submit them to Professor Owen, and also $2,000 worth of gold from the Chaudière gold-field. From London he wrote to his brother:—

"42 SACKVILLE STREET, 21*st. February*, 1852.

"MY DEAR JAMES,— . . . I am engaged night after night with Owen in an examination of the tracks, which make a wonderful display on the floor of the museum of the Geological Society. They cover the whole centre of the room. . . . The anniversary of the

* Geikie's Life of Murchison, II., p. 119.

Society took place yesterday, and the tracks excited great interest.

"It is evident that Owen will modify his views with respect to the animal which made the impressions, and it will be found that my caution in not pretending to decide a matter of which I did not know anything, was quite judicious. The creature will be no tortoise, that is plain.

"The fragments which held phosphate of lime show no bony structure when sliced and placed under the microscope, not even the one most like a bone.* Owen had a drawing made of this one, and expected it would be found to be bone; but the want of structure will decide him not to pronounce it to be bone."

As is now well known, the conclusion arrived at by Professor Owen, after a careful study of Logan's collection of footprints, was that they had really been produced by "some species of Crustacean, but of a family wholly distinct from anything presented by the Crustacean forms of later geological periods, or of the present day."

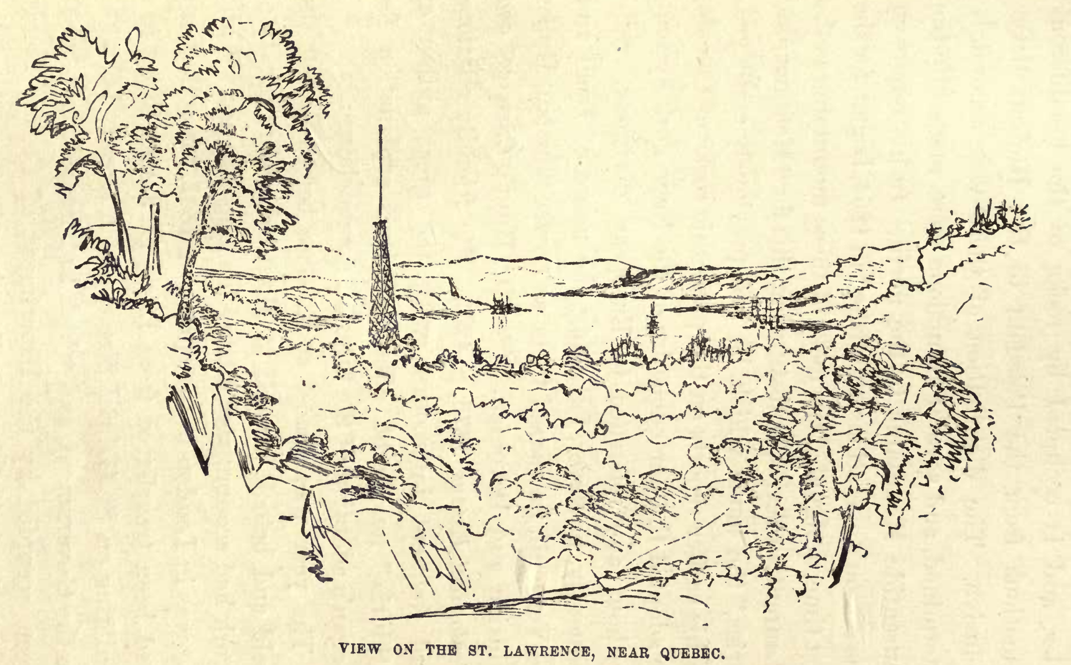
The $2,000 worth of gold represented the work of fifteen men during several months at the junction of the Chaudière and du Loup Rivers, and attracted considerable attention in England. It was exhibited at a meeting of the Geological Society in February, on the occasion of Sir Roderick Murchison's reading a paper on the gold deposits of the world; and at the close of the paper Logan was called upon to give an account of the mode of occurrence of gold in Canada.

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* This was one of the phosphatic nodules from Rivière Ouelle, Kamouraska County, found in a limestone conglomerate of the Levis formation. In outward appearance it closely resembled a cylindrical bone.

In the month of March he read a paper before the Geological Society, and the same evening Professor Owen read one on the Potsdam footprints. After the papers, "there was," says Logan, "a glorious discussion." The following month he went to visit his sister, Mrs. Gower, at Castle Malgwyn, in Wales, spent a couple of days among his old haunts at Swansea, where the foundations of his geological knowledge had been laid, and then proceeded northward to Scotland. There he visited his brother Edmond, in Edinburgh, and his sister Mrs. Ker, of Polmont Manse, Polmont. He also crossed over to Belfast, in Ireland, for the express purpose of seeing the museum there, which he had been told would afford him many useful hints. In May he returned to Canada, and shortly afterwards began an examination of the region on the north side of the St. Lawrence, between the upper end of the island of Montreal and Cape Tourmente, and extending northward to the "metamorphic hills." The examination of this region implied much more labour than might at first be supposed; for although much of it had long been settled, comparatively little of the topography had ever been accurately delineated on any map, and consequently it became necessary to go over the whole ground on foot, and to measure every road and line of exploration travelled."*

* The bearings of the roads and lines were determined by prismatic compass, and the distances by pacing, a method of measurement which Logan ordinarily adopted as sufficiently accurate for his purpose, but which he found most monotonous and fatiguing. "The weariness," he says, "resulting from the attention required to count one's paces accurately every day, and all day long, for five or six months of assiduous exploration, is best understood by those who have made the attempt."



VIEW ON THE ST. LAWRENCE, NEAR QUEBEC.

Note Book, 1854.

The region explored has an area of about 3,000 square miles, and is occupied by rocks of the fossiliferous formations from the Potsdam to the Hudson River inclusive. The distribution of these was accurately determined, and several excursions were made into the Laurentide Mountains to the north. In his report on this season's operations, published in 1854, Logan, for the first time, designated the rocks of these mountains as the "Laurentian Series," substituting this for "Metamorphic Series," the name which he had previously employed. In his earlier reports on the palæozoic rocks of Canada, he adopted the nomenclature of the New York system, without any reference to European divisions. Subsequently, however, following the usage of Lyell and De Verneuil, he classed them as Lower Silurian, Upper Silurian and Devonian. (See Dr. Hunt's *Chemical and Geological Essays*, 1875, p. 420.) His friendly relations and frequent intercourse with the great author of "Siluria" no doubt offer sufficient explanation for Logan's adoption of the Silurian nomenclature.

The year was almost at its close before he left the field and betook himself to Montreal, where plenty of work had accumulated during his long absence. While he was in London in the spring of 1852, his collections had been transferred from Little St. James Street to a building on St. Gabriel Street, which already belonged to the Government, and which had immediately before been occupied by the Department of Crown Lands. Originally it had been built as a private residence by the Hon. Peter McGill, and although not specially designed for a museum it was a great improvement

upon the previous one. It is evident, however, that Logan felt that even this should be but a temporary abiding place, and alluding to the subject in his report for 1852-3, he says: "It may be a consideration whether a growing country like Canada could not afford to anticipate what its future importance may require in the nature of a national museum, and at some time not far distant, erect an appropriate edifice especially planned for the purpose." The removal of the Survey to Ottawa was, of course, not contemplated then.

Some months were spent in the city, but when the summer of 1853 came round, he might have been seen, hammer in hand, among the Laurentian rocks of Grenville, or the adjoining townships, beginning that series of investigations to which, again and again, he was to return in after years, and which was destined to inseparably connect his name with the early geological history of our earth. It was a rough region to which he went– dotted with lakes and traversed by many a turbulent stream—with forests primeval and bogs innumerable—teeming with mosquitos and black flies, but sparingly settled by man—altogether not a very enviable place to study stratigraphy in. But Logan was not afraid to try it; and with indescribable toil and untiring zeal the limestone bands were followed in all their tortuous courses, until, little by little, what at first must have seemed almost chaotic, grew and grew into the order which was eventually delineated on his beautiful map.

The following year he does not seem to have returned to Grenville, but to have devoted such time as the



PITCHER PLANT (*Sarracenia purpurea, L.*),
A common plant in the swamps of the Laurentides.
Logan's Journal.

various distractions of his position permitted to a study of the interesting rocks of Point Levis, opposite Quebec. Preparations had also to be made for the approaching Exhibition at Paris (1855), at which the Canadian Government were anxious to have a good representation of the mineral and other resources of the country. The bringing together of a suitable collection of minerals of course involved much thought and labour, and in this, as in other cases, must have greatly interfered with the regular work of the Survey.

CHAPTER XIII.

THE SELECT COMMITTEE ON THE GEOLOGICAL SURVEY.

FROM the beginning of the Geological Survey, annual Reports of Progress had been submitted to the Government, and then printed for circulation. But the circulation was very limited, and many of the reports fell into the hands of people who made little or no use of them. There were accordingly not a few who felt that some steps should be taken towards ensuring a more general diffusion of the valuable information already accummulated by Logan and his staff. With this object in view, a Select Committee, with power to send for persons, papers, and records, was appointed by the Government on the 26th. of September, 1854. Among those who gave evidence before the Committee at a meeting called for the purpose, in October, besides Logan himself and T. Sterry Hunt, there were the distinguished geologist and palæontologist, Professor James Hall, of the New York Survey; Professor E. J. Chapman, of University College, Toronto; Alexander Russell, Esq., of the Department of Crown Lands, Quebec, and the Rev. Andrew Bell, of L'Orignal. In

the course of the examination questions concerning the whole working of the Survey came before the Committee, and the result was that they were enabled to present to the Government a report which was highly complimentary both to the Director of the Survey and those associated with him. "Your Committee," so runs the report, "think they may pronounce with confidence that in no part of the world has there been a more valuable contribution to geological science for such a small outlay (hardly more than £20,000 in all). In confirmation of this opinion your Committee would refer to the letter of Professor Agassiz, and the evidence of Professor Hall, and to the opinions of scientific men quoted by Mr. Logan and Mr. Hunt. They beg also to add two other quotations as showing the estimation in which our Survey is held by men of science in England and France: 'In Canada especially there has been proceeding for some years one of the most extensive and important Geological Surveys now going on in the world. The enthusiasm and disinterestedness of a thoroughly qualified and judicious observer, Mr. Logan, whose name will ever stand high in the roll of votaries of his favourite science, have conferred upon this great work a widespread fame.—*London Quarterly Review October*, 1854.'"

The second quotation alluded to is from Dufrenoy's report on certain departments of the London Exhibition of 1851, and has already been given on pages 269, 270.

From the evidence of Professor Hall it appeared that although the area of the State of New York was only about one-sixth that of Canada, the annual appropria-

tion for the purposes of the Geological Survey was about $20,000, exclusive of the expenses of publication of reports, which came from a different fund

Mr. Russell, in his evidence, testified to the importance and accuracy of the topographical surveys accomplished by Logan, showing that they had been the means of correcting many serious errors in older surveys. "Mr. Logan," he says, "made a survey of the River Mattawan, a tributary of the Ottawa, and afterwards a regular survey of the same district was made by order of the Department. The two surveys differed by about two chains only in a distance of thirty-eight miles; and in his survey from the St. Lawrence to the Baie des Chaleurs, by the Chat and Cascapedia Rivers, a total distance of one hundred and eleven miles, the difference between his measurements and that ascertained by the latitudes and longitudes of the extreme points, determined by Captain Bayfield, was less than a quarter of a mile. From these instances I entertain a high opinion of Mr. Logan's accuracy as a topographical surveyor."

Logan's own evidence before the Committee is very interesting, and as there are probably many who have never seen it, a few extracts are introduced here. In reply to the question, "What are the principal difficulties you have met with?" he said:

"The principal difficulties I have encountered, independently of those unavoidably incident to travelling in canoes up shallow rivers, and on foot through the forest, are those arising from the want of a good topographical map of the country. Accurate topography is

the foundation of accurate geology. Unless you know the geographical position of every rock exposure that comes before you, you cannot tell the general relations of the whole, and you cannot make the physical structure of a district intelligible to yourself or to others. Without geographical position, the dip and strike of a rock are worth nothing, and the occurrence of a valuable mineral in two localities distant from one another are just two isolated, unrelated facts; while their topographical place being known, their dip and strike may immediately point to the probability, and guide to the search and discovery of the same substance in a hundred places between. It thus becomes necessary in unsurveyed parts of the country to measure correctly, as I have already stated, long lines of exploration. But even in those parts which are settled, neighbouring townships having been surveyed separately and independently, and often not very correctly, it is next to impossible, in putting them together, to get them to fit. Lots, or portions of lots, that are in juxtaposition on the old maps given in to the Crown Land Office, are not so in the field; and in many of the old surveys, lines in one and the same township, such as the township of Grenville, for example, and others in the same neighbourhood, lines that on the paper are represented as straight, go staggering through the bush in zig-zags that would surprise an Indian hunter. In laying down work on such maps as these, it will be seen that, if you have a useful mineral in two distant localities, such a mineral, for example, as serpentine, soapstone, slate, or such like, between which localities

the observed structure of the country tells you the mineral mass should run in a straight line, and you should draw such a line from one to the other on your paper, you might represent the mineral as occurring in lots where it was absent, and leave it out of those where it was present. Or supposing you followed the bed along its strike or direction from point to point, and then placed it on the lots in which it occurred, the result would be that the course of your mineral would appear to have a multitude of what in this country are termed *jogs*. The geological inference to be drawn from the appearance of such on your paper would be, that the mineral band you were representing had been broken or dislocated by what are termed *faults*. The general bearing of your band would be incorrect, and might mislead you, if you were depending on your result for further search; and if a map were published with these jogs, it would deceive geologists and mineral surveyors at a distance in respect to the general condition of the country's structure, making them think it was a disturbed one, and proper for the search of metalliferous veins, when it might have no such veins in it. Such a map would be more deceiving than one on which the railroads were laid down on the right lots in the old Crown Land plans of which I speak. No one would be deceived by the jogs in such a case, for the very nature and object of a railroad would proclaim to every one that it could not have been so located unless the engineer had been insane. The incorrectness of some of the topographical plans, and the fact that we do not know which are right and which are wrong, makes

it necessary for us, even in surveyed parts, to count and register our paces over every road and line we go, taking the bearings by prismatic compass, and registering in its proper place every rock seen, with its dip and strike, and a short description of its character, and its economic and fossil contents, if it have any. If the measurement is on a road, a note is made of the position where it crosses lot or concession lines, where it is coincident with or divergent from them. A surveyor's post is hailed by us as land is by a mariner; it represents a fixed point on the map, and enables us to limit our errors, or to detect those of the surveyor, and gives us a fresh starting point. When discrepancies are small, we give the credit of accuracy to the surveyor; but it often happens that no difference of short or long in the paces is sufficient to account for them, and the township plan is found wrong. Working in this way, Mr. Richardson, an excellent and most diligent explorer, last year paced 1,000 miles in the Ottawa country, between Pembroke and Vaudreuil, keeping a register of every step; and by means of this pedestrian measurement, and township plans, he has been able to complete a map of the whole area on the scale of an inch to a mile, in which many discrepancies in neighbouring townships have been reconciled, and on which is placed, with sufficient accuracy, every rock exposure he saw. There is a part of the area, however, in and about Hawkesbury, which defies this mode of proceeding, and would require a more accurate species of measurement to set it right. It will be easily understood that this geographical work must unavoidably impede the

rapidity of geological examination; and the necessity of so much measurement to fix the position of rock exposures, forces us, in order to make even a moderate progress, to examine fewer of them, or to give to each a shorter time than we would like, and thus, perhaps, to overlook some of its characteristics. . . ."

To question 76, "Do you think any material advantage might be derived from voluntary assistants?"—the answer is:

"There can be no doubt of it. In localities in their own neighbourhood, I have received valuable information from various persons, to whom I have been careful on all occasions to render public thanks. Among others who have thus favoured me are Mr. Abraham, Dr. Wilson, the Rev. Mr. Bell, Mr. Billings, and Mr. Sheriff Dickson. An excellent vein of geological knowledge seems to run up the Ottawa."

The next question (77) asks, "Do you think that you might derive much aid even from persons who are not strictly scientific men?"—and the answer to this runs as follows:

"I am scarcely ever a day in the field in the settled parts of the country without getting a considerable amount of information from farmers and common labourers, particularly among such as are not haunted by the notion that all our researches have the precious metals for their object. By a reference to the Report of Geological Progress presented to the Legislature this session, it will be perceived, at page 142, how this immediately freezes up the fountains of communication. The settlers on the Ottawa, it appears to me, have

got beyond the chance of such an epidemic, perhaps through the influence of some of the gentlemen I have named, and the *Ottawa Citizen*, which occasionally gives them a good, sound geological leader. I have been informed, however, that when my friend Dr. Wilson first began his mineralogical researches, and used to carry home large blocks of stone to his premises, some of his neighbours imagined that, if he were not searching for gold, no other motive could reasonably justify his proceedings, and he might have suffered severely in parochial estimation, had not one, more sagacious than the rest, explained the matter to his own satisfaction and that of the community, by announcing that of these stones the doctor made medicine. On the Ottawa, more than anywhere else, the settlers have appeared to appreciate what we were about, and have shown a readiness to give information and assistance. Last summer I was engaged in tracing out the crystalline limestone interstratified with the gneiss of the Laurentian series, in various townships on the north of the Ottawa, from Abercrombie to Grenville. After following a wide band of the rock from the mouth of the Calumet for five or six miles, and explaining as I went the character of the stone to the inhabitants, who in general did not seem to know it, I came to the shanty of Mr. McHardy. He had been a tradesman in Montreal, and having ascertained by experiment that the valley was underlaid by limestone, he was prepared to give me a good deal of information about its distribution. He informed me that this band joined one which ran irregularly with it, and formed the bottom of

another valley to the eastward. This I had traced for several miles, but had not come to the junction, nor had I expected it. Making search through the bush some days afterwards, in consequence of his information, I found his opinion to be just, and it led me to a better knowledge of the structure of the district, and prepared me for what was to be expected further on. Mr. McHardy had tried what he considered the best part of the stone, because the hardest and least affected by the weather, and although he had made lime from it, it was not of a satisfactory quality, being too sandy. I showed him that instead of taking the best he had taken the worst stone, the quartz and feldspar in it, which produced what he called the sand, being just the portion which prevented disintegration by the weather. The best stone, I showed him, was that which fell into grains, somewhat like salt, and, by means of my acid, that the salt-like granular soil was almost purely calcareous, and I informed him that he had only to dig through this, which would not be very thick, and he would find excellent limestone below. Mr. McHardy informed me of several exposures of the rock between the valleys, and while clambering about a wooded knoll above a road, in search of one of them, I was joined by a respectable-looking, smart old settler, who very civilly, in an accent that let me know at once he was from the north of Scotland, asked me what I was about. On my informing him, and explaining to him the external appearance of the rock, and showing him the effect of acid on it, he told me that if I would come up to his place in Harrington, he would show me miles

of it; that it surrounded several lakes in his neighbourhood, and that having a small birch-bark canoe, which was easily transported from one lake to another, we could visit them all. I told him I would take him at his word, and pay him for his trouble. Carrying with me a small stock of provisions, I went up a few days afterwards, to the residence of my Highland friend. He is probably some distant relation of the Duke of Argyll, for his name is William Campbell. He emigrated to the country many years ago from the Isle of Skye, where he pursued the calling of a fisherman, and he has been gradually followed by a whole clan of his relations, for each of whom in succession, as for several of his sons, who are all grown up to manhood, he has selected a lot of land in his own neighbourhood. Mr. Campbell first indicated to me one or two exposures of limestone on his own farm; but I soon made him understand from these and others on his neighbours' lots, as well as the run of the stratification, that his farm, which is an excellent one, was underlaid by the rock from one end to the other, and it was found that on every lot he had chosen for his relations there was more or less of it, indeed, on almost every cultivated lot of the settlement; and it was not difficult to convince Mr. Campbell that the soil was dependent on the limestone for its good quality. Mr. Campbell accompanied me for upwards of a week before he had exhausted all the localities in which he had at one time or another seen the rock, within a range of eight miles around his house, the greatest extent being on the lakes he had mentioned, where he had ascertained every

exposure on various fishing excursions, to which, at the proper season, he has recourse for the purpose of supplying his family with provision for the winter. Mr. Campbell seemed so taken with our investigation that he proposed to me to send him a compass, a hammer, and a small bottle of acid, in order that he might extend his researches. These I sent him, and he subsequently brought me information to Montreal of the existence of the rock in several lots in Wentworth and elsewhere, with specimens. . . ."

Notwithstanding the generally favourable impression which Logan and his work had made upon the people of Canada, there must have been many who were still sceptical as to the advantages which the country would derive from a Geological Survey; who felt, no doubt, that many facts of interest to scientific men might be evolved, but thought at the same time that there was little of a practical character in the work. The Committee were well aware of this, and did not fail to interrogate Logan closely on the subject. "Can you," they asked, "give any illustration of the manner in which a sound scientific basis leads to practical economical results?" And again: "Have you in your survey had as your principal object the establishment of new scientific facts, or has your attention been more directed to discovery and pointing out economic advantages?" From the answers to these questions we give only the following:-

"A considerable portion of the science of geology is devoted to tracing out the distribution of the various formations that come from beneath one another and

spread over the surface of a country, the mode of representing these being by colours on a map. What is this, in an economic point of view, but a classification of its surface into parts, each of which will give useful materials peculiar to itself? So much is this the case that Dr. Buckland, in his Bridgewater Treatise, has shown that a geological map of England is a map also of the distribution of its manufactures. Such a map will point out the limits to be observed in searching in new localities for materials that are known, and make every man's discovery of any useful material, not previously known, available to his neighbours in a hundred new places. For example, I was informed not an hour ago by Dr. Taché, that Mr. Gauvreau, of Quebec, has made from some of the strata on which the city stands a very good cement. It will immediately be seen by those acquainted with the geology of the country that this is a discovery not for Quebec alone, but for hundreds of places between this and Missisquoi Bay, and for hundreds of places along the south side of the St. Lawrence below this. . . ."

"The object of the Survey is to ascertain the mineral resources of the country, and this is kept steadily in view. Whatever new scientific facts have resulted from it, have come out in the course of what I conceive to be economic researches carried on in a scientific way. . . . Mr. Hunt's valuable contributions to the London Philosophic Magazine and other scientific journals of repute, on the metamorphism of rocks, are the result of chemical analyses made to compare the constituents of European roofing slates with those of Canada in refer-

ence to probable durability, and of other analyses with a more scientific end, that of determing whether shale, caught as it were in the act of metamorphosis through contact with trap, and becoming what he has called *parophite*, from its resemblance to serpentine, really contained the same chemical constituents in both cases. He found that it did so. But while the economic analyses became related to a scientific result, the scientific analyses pointed to one that might become of economic value. The shale was found to contain so much potash that it would not be surprising if in some cases such schists might turn out profitably available for this substance.

"The analyses of new mineral species, while they directly regard a scientific result, must always have an economic bearing. You cannot tell whether a new substance is to be profitably available or not until you have ascertained its properties. The analyses of mineral species led to our knowledge of the lime-feld spars, of so much agricultural importance to the Laurentian country.

"Thus economics lead to science, and science to economics. The physical structure of the area examined is, of course, especially attended to, as it is by means of it that the range or distribution of useful materials, both discovered and to be discovered, can be made intelligible. A strict attention to fossils is essential in ascertaining the physical structure. I have been told that some persons, observing how carefully attentive I endeavour to be to this evidence of sequence, have ignorantly supposed the means to be the end, and while

erroneously giving me credit as an authority upon fossils, have fancied economics to be sacrificed to them. In their foolish darkness they have mistaken my rush-light for a sun. I am not a naturalist. I do not describe fossils, but use them. They are geological friends who direct me in the way to what is valuable. If you wish information from a friend it is not necessary that you go to him impressed with the idea that he is a collection of bones peculiarly arranged, of muscles, nerves, arteries, and skin, but you merely recognize his face, remember his name, and interrogate him to the necessary end. So it is with fossils. To get the necessary information from them you must be able to recognize their aspect, and in order to state your authority you must give their names. Some tell of coal; they are cosmopolites; while some give local intelligence of gypsum, or salt, or building stone, and so on. One of them whose family name is *Cythere*, but who is not yet specifically baptized, helped us last year to trace out upwards of fifty miles of hydraulic limestone.

"My whole connection with geology is of a practical character. I am by profession a miner and a metallurgist, and for many years was one of the active managing partners in an establishment in Wales, where we annually smelted 60,000 tons of copper ore, and excavated 60,000 tons of coal. It was my constant occupation to superintend and direct the minutest details of every branch of the business. A due regard to my own interests forced me into the practice of geology, and it was more particularly to the economic bearings of the science that my attention was devoted."

So thoroughly were the members of the Select Committee convinced of the importance and practical nature of the work being carried on by the Geological Survey, that they recommended the provision of greatly increased facilities for the continuance of the work, and a "republication of not less than 20,000 copies of the revised reports, with a coloured map." The results of the revision of the earlier reports and the addition of new facts acquired during the further progress of the Survey, are to be found in the *Geology of Canada* and on the beautiful geological maps to which we shall refer later on.

CHAPTER XIV.

THE PARIS EXPOSITION OF 1855, AND ITS FRUITS.

WHEN the spring of 1855 arrived, Logan again found himself amid the final bustle of preparation for another great exhibition. Most of his collection of minerals had already been forwarded to Paris, and early in the month of April he left Montreal for the same destination. On his way to Boston he stopped at Albany to see Professor Hall, to whom he had confided the description of those "remarkable graptolites" which had been discovered at Point Levis during the previous year in rocks then supposed to belong to the Hudson River formation.* From Boston he wrote to his brother on the 10th. of the month: "I went out to see Agassiz to-day. Hunt and I spent two hours with him, and dined with him and his family." The following day, accompanied by Hunt, he sailed for England on board the "Asia," which was crowded with passengers almost

* Writing about these graptolites, in 1858, Professor Hall says:— "This discovery gave, for the first time, a knowledge of the forms and mode of growth of these fossils, of which fragments and detatched branches have for so many years been described as complete forms. Neither up to that time, nor so far as I am aware to the present, has any evidence of the existence of perfect forms such as these been given to the public."

to overflowing. Notwithstanding that the "English beer, the salad oil, the eggs, the fresh-fish," and sundry other good things ran short, the voyage was a pleasant one, and Liverpool was reached on the 23rd. of the month. A single day was spent in London, and there Logan's friends "were delighted to see him in such good health and spirits."

Convenient rooms had already been secured for the two Canadian Commissioners* in Paris, at 35 Avenue d'Antin, in front of the Palais de l'Industrie, and here Logan took up his quarters. But scarce had he arrived in the French capital when an event occurred which produced a most profound sensation. It was the attempt of the Italian Pianori to assassinate the Emperor Napoleon as he walked in the Gardens of the Tuileries, on the 28th. of April. A meeting of the British residents, it will be remembered, was shortly afterwards called at the British Embassy, to vote an address of congratulation to the Emperor on his escape from the bullet of the assassin, and Logan was chosen as one of the members of the deputation appointed to present the address. The reception of the deputation he describes in the following letter :—

"35 AVENUE D'ANTIN,
"PARIS, 10*th. May*, 1855.

"MY DEAR JAMES,—Our space in the Annexe has at last been definitely arranged, and we have about 7,000

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* The two "Special Commissioners" from Canada were Mr. W. E. Logan and Mr. C. C. Taché, M.P.P. A number of other gentlemen were, however, appointed by the Government as "Honorary Commissioners." For details concerning this Exhibition, See *Canada at the Universal Exhibition of* 1855, containing reports by Taché, &c., &c.

feet—about enough to show our materials completely. They will be all kept together in one spot, with the exception of the machines which require motive power. These will be in another part of the Annexe.

"The opening is announced for the 15th.; but the inside arrangements will not be complete in the *Palais* by that time, and in the Annexe not for a long time after.

"The French are abominably careless in bringing the materials to be exhibited from the coast. I have been informed that three out of every five of the mirrors sent by British exhibitors have been broken—many of them utterly smashed. Among the Canadian packages, some, by the sounds emitted from their interior, give evidence of breakage. I hear a great rattling in one from Quebec containing wax flowers, and broken bottles sound from one of those from Montreal. It is fortunate that I made such free use of barrels for my materials.

"The deputation with the address waited on the Emperor on Saturday last, at half-past twelve o'clock, and of course I had a good opportunity of seeing both the Emperor and Empress. We awaited them in a magnificent chamber with a double row of chandeliers, the third in the suite we passed through, and after a delay of about a quarter of an hour, the Emperor and Empress, with the whole Court, came through the room on their way to the chapel. Lord Denbigh presented the address without reading it, and the Emperor thanked him for it in English, and in a very low tone of voice—so low that, though I was not more than four feet from him, I could not clearly make out what he said. We were then all presented in succession to

both Emperor and Empress, I being announced as Commissioner to the Exhibition from Canada. We each had a gracious bow and smile from the Emperor, and then from the Empress.

"To me it appears that the Emperor is a better looking man than his portraits represent, and the Empress, though like her portraits, is not quite so striking as represented. Her features are small, and it seemed to me that there was a slight expression of anxiety and distress in them which detracted from her beauty. .

"I attended the Geological Society on Monday evening last, and presented a proof of the engraving of my graptolites, giving also a *vivâ voce* account in French of the position in which they are found."

Notwithstanding that the arrangements were still far from complete, the opening of the Exposition took place on the 15th. of May. "There was, of course," writes Logan, "a great crowd, and the whole thing was grand and beautiful; but a large portion of the preparation was intended to cover up the want of forwardness in the arrangement of the materials. . . . Of course I attended the opening as Commissioner, with Mr. Taché, and although we were among the magnates, we had not a very good position. A corner of one of the cases which had been covered up to conceal it, interrupted our view. The Emperor and Empress, however, and all the Court, passed close by us, and we had a good view of them.

"At the opening I met Mr. Dufrenoy, who appeared very glad to see me, and shook hands with me most

cordially, alluding to our conjoint work at the Exhibition of 1851."

On the 31st. of May he again wrote: "Our weather is cold and disagreeable. It rains to-day, and a fire would be very pleasant. I cannot say that I have been charmed with the sky of *la belle France* as yet.

"Mr. Hunt is to have a paper read before the Institute of France on Monday next. It is to be brought forward by Dumas, who takes a great interest in Hunt's investigations in chemical philosophy and has given him great praise, telling him that some of his points are quite new and very important.

"For the last week I have laboured hard at our catalogue, which must be given in by the 5th. of June. It has kept me up until after midnight for several days. . . . I have seen no sights, my whole occupation being in connection with the work of the Exhibition."

Owing to the general confusion of the "Annexe," it proved impossible to complete the arrangement of the Canadian division until late in June, although Logan had toiled almost unceasingly. He could not be induced to leave his work long enough to see the review of 30,000 troops in honour of the King of Portugal, but attended the grand ball at the Hotel de Ville, at which there were between 5,000 and 6,000 people present. On the 4th. of July he wrote to his brother James: "The Annexe has now been open for some time, and our division looks well. I have been intensely occupied colouring a geological map, and am nearly worn out. Last Monday night I did not go to bed until two o'clock, and then got up again at four. . . . Mr. Hunt

has been made an Associate Juror, by which means I hope to have the Canadian minerals properly represented. He has made two communications to the Academy. One of his papers was read by himself, and the other was presented by Mr. Dumas. He has also made two communications to the Geological Society. He was elected a member of the Society the first time of his appearance at their meetings."

In the month of August the Queen, Prince Albert, and the young Prince of Wales, visited Paris, and of course went to the Exposition. Accompanied by the Emperor, Her Majesty passed through the Canadian Court, and Logan, who was there at the time, refers to the occasion in the following letter:—

"CANADIAN SECTION, INDUSTRIAL EXHIBITION,
"PARIS, 30*th. August*, 1855.

"MY DEAR JAMES,—I have regularly received your weekly communications up to this time, but have not written to you now for several posts. The fact is I am so constantly occupied with worrying matters of small detail that I never can find a moment of repose, and yet when all is finished, I cannot see what I have been doing.

"Hart, Edmond, and Eliza, are here just now, and have been since last Tuesday week. Of course I have endeavoured to spend as much time with them as possible, and this has been a slight relaxation for the period. They, like the rest of the world, have seen some of the proceedings of the Queen's visit, and were in the Canadian division when Her Majesty passed through. But for all that relates to the Queen's visit, I must refer you

to the newspapers. No doubt you will take notice of Mr. Logan's dialogue with the Queen. It did not happen quite as Galignani's *Messenger* gives it; for it began by my addressing Her Majesty, instead of Her Majesty me. This perhaps was somewhat contrary to etiquette, and one of our honorary Commissioners told me that I had been *un peu audacieu.* There was no one, however, to present me, and if I had not spoken without presentation, nothing would have been said at all, and Her Majesty would have had no opportunity of saying what she did touching the Canadian section, and of thus pleasing the Canadians.

"You will see that in the *Times* report, the Commissioners waiting on Prince Albert at his levee are said to have been very frank. This, I have no doubt, arises from the anecdote I gave to Prince Albert showing how little Canada was known in France. A respectable Frenchman said to me, '*Le Canada est en Peru, n'est-ce pas?*'"

In the month of October Logan went over to London to confer with the authorities at Sydenham Palace, and ascertain what they were willing to do in the way of a permanent exhibition of Canadian products. He had already been given to understand that they were desirous of obtaining a portion of the collection exhibited at Paris, and, in common with many others, felt that no disposal of these articles could be made which would be productive of greater good to Canada. Many of them were eventually sent there; others found their way into the Conservatoire des Arts et Metiers, the Jardin des Plantes, the École des Mines, &c., and a good

many were sold or returned to the exhibitors. Attending to the packing up and distribution of these things necessarily occupied a good deal of time, and it was about the 20th. of December before Logan was able finally to leave Paris. Some time before this, however, the rewards for all his hard work in connection with the Exhibition had begun to pour in upon him. "You will see by the newspapers," he writes to his brother on the 22nd. of November, "that I have got a Grand Gold Medal of Honour for my map and minerals, and that I have been presented by the Emperor with the Cross of the Legion of Honour. This is as much as I could possibly get at the Exhibition, so that personally you must know that I am content." But if the Emperor of the French had made him a Chevalier of the Legion of Honour, a greater distinction awaited him at the hands of his own Sovereign. This he announces to his brother in the following letter:—

"35 AVENUE D'ANTIN,
"PARIS, 29*th. November*, 1855.

"MY DEAR JAMES,—We have nearly wound up our affairs here. We are packing up those things which are to be returned to Canada, and those which are to be exhibited at Sydenham Palace. There are a few things also which we are sending over to London for sale there. . . .

"It has been intimated to me from the Home Office in London that my name has been submitted to Her Majesty for knighthood, and Her Majesty has been pleased to signify her pleasure to confer on me that dignity, for services rendered at the Exhibitions of 1851

and 1855. You need not tell any one this, lest some slip should take place between the cup and the lip. But I have been requested to call at the Home Office in order that I may be informed when I can be presented —which it is probable may be before I return to Canada. . . . I see by the newspapers that my friend Mr. Dawson has been regularly installed as Principal of McGill College. He will be a support to the Survey, for he is really a man of science.—Yours truly,

"W. E. LOGAN.

On the 29th. of January, Logan was knighted by the Queen at Windsor, and afterwards enjoyed the privilege of paying to the Fee Fund Commissioners "the Fees of Honour due to the Officers and Servants of Her Majesty's Household." About this time also, he was informed at a meeting of the Geological Club that the Palladium or Wollaston Medal—"the greatest honour the Geological Society has to bestow"—had been awarded to him. The public announcement of this was to take place at the annual meeting of the Society several weeks later, but Logan felt that he could not remain for this occasion, as he had already been absent from Canada for nearly a year. In his absence, however, Sir Roderick Murchison received the medal for him. Mr. W. Hamilton was then the President of the Geological Society, and after he had pointed out in an eloquent eulogium the grounds on which the Council had awarded the Wollaston Medal to Sir William Logan, Sir Roderick Murchison replied:—

"SIR,—As Sir William Logan was in the earlier part of his scientific career a distinguished contributor to the

British Geological Survey, and as my lamented predecessor, Sir Henry De la Beche, had formed the highest opinion of his capacity, it naturally gives me sincere pleasure to be the medium of transmitting to him this Wollaston Medal.

"Although the Atlantic has subsequently separated us for most of the period during which our medallist was occupied in successfully advancing geological science in his native country, Canada, it has been a source of true gratification to me to observe the very able manner in which he has elaborated the full and accurate succession of the most ancient rocks of the vast regions he has surveyed, and how clearly he has separated the great series of fundamental, sedimentary, unfossiliferous rocks termed Laurentian, or Cambrian, from those Silurian rocks which, in common with all geologists of the United States until the present moment, he has placed in parallel with the *Lower* as well as the Upper Silurian of Britain and Europe.

"The skilful manner in which he has followed out the course of these ancient Silurian deposits from their undisturbed and unbroken sequence over vast tracts in the West, to the sea-board or Eastern region of North America, where they have been contorted, broken up, metamorphosed and mineralized, will doubtless be considered among the most remarkable labours of our honoured associate!

"Whilst in his younger days he established, by close and repeated observations, that natural history constant to which you have so justly alluded, and which has enabled us to read off the true history of the greater

number of coal-fields, his maps and sections illustrating the structure of the Canadas, prepared in the vast wilds of that country, amidst hardships and privations unknown to European explorers, will be the imperishable records of his fame as a practical geologist.

"The devotion and untiring energy with which he arranged, developed and explained the natural productions of Canada, first at the great British Exhibition of 1851, and recently at the grand Exposition of France, have obtained for him honours both from his own gracious Sovereign and from the Emperor of the French, and I have now only to assure you, sir, that no one of these well-merited honours will be more highly estimated by him than the marked approbation of his brother geologists in bestowing upon him their highest distinction, the *Wollaston Medal.*"

On the 21st. of February, Murchison wrote to Logan telling him about the meeting. "Our anniversary," he says, "went off well, and in no respect better than in the acknowledgment of your services, *by all concerned.*

"I was asked to take the Wollaston Medal for you, and previous to delivering it to me Hamilton enumerated with due praise all your doings. In my reply I took care to allude specially to what he did not touch upon, your success at *the Exhibitions.* As you may like to hear what I did say, I send you a copy of my little speech (as it will be printed).

"I took care, as you see, to vindicate my *Lower* as well as *Upper* Silurian, and called you to my defence over large regions of North America, as well as *all* your

American (United States) precursors; Rogers sitting opposite!

"His general map, as just issued or issuing by A. Keith Johnston, has *hurt my feelings exceedingly.* . . . It is very offensive to ignore Lower Silurian altogether, and to call the Llandeilo rocks Cambrian! Besides this fundamental begging of the whole question and the slicing off from me of half of my original rocks, he has coloured all the Arctic and northern region as Cambrian, where every one knows it is Upper Silurian.

"I should like to see your Wollaston announced in the manner of my enclosed document in your Canadian journals. I enclose the medal to your Governor, who is an old acquaintance of mine.

"If you hit upon any good things in *re Siluriana,* let me know of them.—Yours very sincerely,

"RODERICK I. MURCHISON."

It was late in February when Logan reached Canada, where he would gladly have been allowed to retire to his museum for a time to commune with his rocks and fossils. But his fame had preceded him, and now he was not to be left without honour in his own country, the interests of which he had done so much to advance while abroad. Dinners, addresses, testimonials, congratulations, were in store for him, and again and again he was to go through that ordeal of speech-making which his nervousness always made him look forward to with dread.

The Geological act passed in 1850 had expired, and shortly after his return from Paris we find him at Toronto, doing all in his power to urge on the passage

of the new bill making provision for more extended operations of the Survey. On the 22nd. of March he writes from Toronto: "I am busy making out my accounts connected with the Paris Industrial Exhibition. At the same time I am constantly interrupted by visitors, and my progress is but slow. I am sitting for my picture to be painted for the Toronto Institute. To aid the artist and enable him to work with as few sittings as possible, a photograph has been taken of me to-day. I understand the Toronto Institute intend to present me with an address some time when they have a meeting, and when they do so I am sure I shall not be able to find much to reply. . . .

"Mr. Langton tells me he thinks that all things considered, there is no doubt the geological act will be passed, and he says that Mr. McDonald, the Attorney-General West, has promised to take it in hand; but I suspect it will require great looking after.

"The day after my arrival, which was Monday, I had an interview with the Governor, and an invitation to dine with him and Lady Head in a quiet way. He put into my hands the Wollaston Medal which had been forwarded to him by Sir Roderick Murchison."

The hanging of Sir William's portrait and the presentation of the address took place on the fifth of April. The address was read by the President, Mr. G. W. Allan, who introduced it with the following remarks:—

"GENTLEMEN,—Before proceeding to the other business of the evening, we have a gratifying duty to discharge to the distinguished and honoured guest who is with us to-night. You are all aware that our resolu-

tion to adopt some special mode of marking our sense of the valuable services rendered to Canada by the eminent geologist who first filled the office of President of this Institute, had been fully considered and recorded before the pleasing intelligence reached us that the valuable labours of Sir William Logan, in the cause of science, had been honoured by a distinguished mark of the favour of his Sovereign; and that so soon as we had ascertained that his return to Canada, for which he had done so much, might soon be expected, it was unanimously resolved that we, the members of the Canadian Institute, should take the first opportunity, as a body, to tender him our congratulations on his well-merited honours; and further, that we should request him to sit for his portrait, to be hung up here as a lasting memorial of one to whose name we could always point with pride and satisfaction, as the first Canadian who has achieved for himself an European reputation in the world of science. And now, Sir William, with your permission, I shall proceed to read the address, on behalf of myself and my brother members, which I am sure is not the language of mere formal compliment, but is sincerely expressive of the feelings of affectionate esteem and respect entertained towards you by every member of this Institute."

ADDRESS

"*To Sir William Edmond Logan, F. R. S., F. G. S., &c., &c.,*
"*Canadian Provincial Geologist:*

"We, the President, Council, and Members of the Canadian Institute beg to offer you our cordial welcome on your return to Canada, after the successful comple-

tion of your labours on behalf of the Province at the Parisian Crystal Palace, and to tender to you our most hearty congratulations on the high, but justly merited, honours with which it has pleased Her Majesty to mark her sense of your distinguished merits as the foremost in the ranks of scientific men in this Province of the Empire.

"We rejoice in the fresh evidence which your reception of the distinguished honour of knighthood affords, of our full share, as Canadians, in all the honours and privileges which pertain to the members of the United Empire; while we feel a peculiar gratification, as members of this Institute, in hailing as the recipient of one of the highest distinctions conferred on men of science by the British Sovereign, one on whom the first choice of this Institute fell to fill its presidential chair.

"In now adorning our hall of meeting with your portrait, permit us to assure you that while our estimate of your distinguished rank as a scientific geologist, and your disinterested and indefatigable zeal in all that can develope the resources and promote the true interests of Canada, cannot be affected by any distinctions conferred on you, we fully sympathize in the just pride which you must feel in being made a recipient of the same honours which British sovereigns have already employed to mark with peculiar distinction the intellectual achievements of a Newton, a Davy, a Brewster, a Lyell, and a Murchison. Nor can we withhold the expression of our congratulations on other no less merited honours, and especially on your receipt, by the award of your scientific brethren, of the Wollaston

Medal one of the highest marks of distinction with which they could testify their sense of the rank you have achieved in your labours as a Canadian geologist.

"In the same spirit we now seek to confer on you such evidences of our appreciation of your successful labours in the cause of science as it is in our power to bestow; and, humble as is our position in relation to science, we venture to hope that our cordial congratulations will not be the less acceptable that they are addressed to the most distinguished among the scientific men of Canada, by a Canadian Institution."

Sir William Logan then replied:—

"MR. PRESIDENT,—I am very grateful to yourself, to the Council, and to the members of the Canadian Institute, for the very flattering manner in which you have been pleased to speak of me in your address—for your kind welcome, and for the congratulations which you offer me, on my success in France and in England. Whatever distinctions, however, may be bestowed on us at a distance, it is upon the respect, esteem, and confidence shown us at home that our happiness and satisfaction must chiefly depend. I can assure you, with sincerity, that the honour conferred upon me when you elected me the first President of the Institute was one highly prized, although the circumstances of a distant domicile, and the intent pursuit of the investigations with which I am charged, rendered it extremely difficult for me to be of much use in your proceedings. And I feel it as no slight compliment that you should place a memento of me by the side of my friend, and much more worthy successor, Colonel Lefroy, whose

constant exertions in the exact observation of meteorological phenomena have tended so greatly to spread the name of Toronto in the scientific world. It is a fortunate circumstance for me that my name should be connected with an act of grace on the part of Her Majesty, which serves to confirm your feeling in regard to the fact that as Canadians we enjoy a full share in the honours and privileges of British subjects; and I am proud to think that it was, perhaps, more because I was a Canadian in whom the inhabitants of the Province had reposed some trust, that the honour which has been conferred upon me by Her Majesty was so easily obtained. That I am proud of the honours which have been bestowed upon me by the Emperor of France, in respect to my geological labours, and also by my brother geologists in England, there can be no doubt. But I have striven for these honours because I considered that they would tend to promote the confidence which the inhabitants of the Province have reposed in me, in my endeavours to develope the truth in regard to the mineral resources of the Province; and in this work none could have been more interested in my success than the members of this Institute. We have on the other side of the hall an evidence of the interest taken by the Institute in the Geological Survey, and you have, in publishing what appears within that frame, published the one-half of what is included in the enlarged map which I presented to the Exhibition at Paris. You have in it the whole of the geology of Canada, as far as it is at present understood, and I think it will, perhaps, not be disagreeable to you

that I should submit a short account of its leading features."

The map alluded to by Logan as hanging up on the "other side of the hall," was a small geological map, which had been published some time before in the Journal of the Institute, to illustrate a paper by him "On the Physical Structure of the Western District of Upper Canada." On the opposite side of the hall hung the large geological map of the whole Province, which had been exhibited at Paris.* In commenting upon this, Sir William called attention to the conformity of the physical structure of the country to its geography; to the difference in conditions between the eastern and western troughs of North America which run through Canada; and to the absence of the Lower Silurian between the Laurentian and Upper Silurian on the north side of the "granite ridge"—showing the existence of land to the north, while the Lower Silurian deposits were accumulating to the south.

On the day following, he wrote to his brother:—

"TORONTO, *6th. April*, 1856.

"MY DEAR JAMES,—The hanging of my picture and the presentation of an address to me by the Canadian Institute came off last evening. I am sorry to say that I made but a poor exhibition in my reply. I was so

* A sum of money had been voted by the Canadian Legislature among the contingencies of 1854 for the publication of a geological map of Canada, and Logan had gone so far as placing the one exhibited at Paris in the hands of an engraver there. It had, however, been rather hurriedly prepared, and after his return to Canada, he made up his mind to abandon it, and to undertake the construction of a new one.

agitated that I could scarcely speak, and it was with great difficulty that I could bring to my mind what I had prepared to say; and really I do not know exactly whether I did utter what I intended. After my reply I endeavoured to explain some of the features of my map which was hung up in the room, but I could not get over my nervousness, and almost stuck in my description for the want of a simple word, which would not come to my mind. Heaven help me if I am agitated in this way on Saturday next, as I shall in that case make a great mess of the matter. If speech-making is to become a consequence of distinction, I shall soon wish distinction far off. I very much fear that repeated attempts would soon be the death of me.

"I must, however, get through it, and I hope by and by to be left in peace to go on with my survey. I am informed that the Council have determined to take up the Geological bill, but I do not know when they will introduce it into the House, and fear that were I to go away they would forget it altogether."

The occasion to which he here looked forward with dread on account of his being expected to make another speech, was the complimentary dinner which was tendered to him by the citizens of Toronto on the 12th. of April. In a letter written to his brother James, a few days after the dinner, he says: "I am so much occupied with one thing and another that I can scarcely find time to sit down and quietly write to anybody. You may suppose that the dinner which was given me last Saturday kept me somewhat uneasy for several days beforehand. I made but little preparation

as to the manner in which I should say what I had to say, but the ideas or subjects of my discourse came several times before me. The Governor spoke remarkably well, and what he said was to the point. I did not feel in the slightest degree embarrassed when my turn came, though I was a little nervous. I had determined not to attempt anything fine, but to say in a quiet, natural manner what I considered judicious. Most people appear to think that I succeeded pretty well. . . . I am looking after my geological bill, but it is difficult to get the Government to act. Mr. Attorney-General McDonald has it in hand. The bill has been adopted by the Government, I believe, in all its details. The sum is to be £5,000, and the time five years. There appeared, however, to be a little hesitation the other day about the five years, as I judge from a word dropped by Mr. McDonald, and I must get my friends to keep the Government to the time. . . .

"I have dined out nearly every day since I have been here—twice with Professor Chapman, with the Bishop of Toronto, with Mr. Mowat, twice at Government House, with Mr. Adamson, Mr. Killaly, Mr. Gzowski, several times with Mr. Robinson, with Mr. Stayner, and others. To-day I am engaged with Mr. Moffat, and to-morrow at Government House. . . . I wish my bill were passed, and I could get away and be quiet down with you."

But although he did soon get to Montreal, the hoped for quiet was not obtained; for another round of entertainments and addresses awaited him. On the 20th. of May a soiree was given in his honour by the Natural

History Society of Montreal, at the rooms on Little St. James Street, and in the course of the evening the following address was presented to him:—

ADDRESS

"*To Sir William Edmond Logan, Knight, F. R. S., LL. D., &c.,*
"*&c., Chevalier of the Legion of Honour, Director of the*
"*Geological Survey of Canada:*

"SIR,—It is with feelings of sincere pleasure, mingled with no small degree of pride, that we, the President and Members of the Natural History Society of Montreal, welcome you as our guest on the present occasion. We have invited you here this evening, not merely from a sense of duty, nor in consideration of the honour your presence would confer upon us, but likewise for the purpose of testifying publicly the interest which we, as a scientific institution, have always taken in your increasing, indefatigable labours to advance the cause of geological science in Canada. It is for this latter reason that the opportunity now presented of acknowledging your valuable services both to science and our country affords us unfeigned gratification. As Director of the Geological Survey of this Province, you have laboured for a long series of years with unremitting zeal and assiduity; and if your untiring efforts have surmounted the many difficulties of a scheme in its nature so extensive and gigantic, and have at length met with that success to which they are so justly entitled, we rejoice to think that the rewards, so honourably gained, have been acquired by one whom Canada claims not only as her brightest ornament in science, but as her honoured and cherished son.

"Limited as have been the means hitherto placed at your disposal in order to carry out your investigations, you have nevertheless, by skilful economy, and at much personal sacrifice, succeeded in bringing to light the valuable internal resources of our country, and of raising our Province to that high and important position which it now holds in foreign estimation. That the Provincial Legislature has appreciated your past labours, and is convinced of the necessity of continuing the noble work under your guidance, is abundantly proved by the munificent grant of the present session towards the Geological Survey; and we believe this is but an echo of the mind of an intelligent public.

"Your unwearied efforts when in London and Paris, on two memorable occasions, have been acknowledged in a manner which must be very gratifying to you, and while we congratulate you upon the high honours received at the hands of our most gracious Queen and of His August Majesty the Emperor of the French, we are no less rejoiced to know that Science, from its loftiest throne, has not omitted to present to you the highest tributes of praise, and its rarest token of reward in acknowledgment of your valuable researches and discoveries in one of its most interesting and important departments. The value of such honours can only be measured by the severe toils and hardships of those mental and bodily labours which have so happily gained them; and our humble prayer is that you may long live to enjoy these rewards, and to continue to prosecute those researches which will prove lasting

memorials of your talents and perseverance, and be of permanent benefit to the country.

"In thus tendering you our hearty congratulations, we beg respectfully to present you with the highest mark of esteem and recognition our Society can bestow —namely, the Diploma of Honorary Member of the Natural History Society of Montreal.

"F. MONTREAL, President.*

"A. N. RENNIE, Rec. Sec.

"MONTREAL, 20th. May, 1856."

Many of the citizens of Montreal were also desirous of testifying in some marked way to their appreciation of the services which Logan had rendered to the Province, and of giving expression to their high estimation of his labours in the field of science. In the thirteen years during which he had directed the Canadian Survey, he had in every way identified himself with the interests of his native city, and had endeared himself to all who had come into personal contact with him. No doubt there were those who felt that any attempt to add to the lustre of his European reputation would be like gilding refined gold; but those who knew him best knew well that any mark of the appreciation and sympathy of his fellow-townsmen was sure to be gratifying to him. It was accordingly resolved to present him with a testimonial, and, after much discussion, a massive silver fountain, engraved with designs illustrating the palæontology of the Carboniferous era, was decided upon. The fountain rested

* The late lamented Bishop Fulford.

upon a pedestal of ebony, intended to represent a bed of coal, and on one of the faces of the pedestal was a plate with the following inscription:—

In commemoration of
His long and useful services as
Provincial Geologist in Canada,
and especially his valuable services in connection with the
Exhibition of All Nations
in London in 1851, and in Paris in 1855,
by which he not only obtained
higher honour and more extended reputation,
but largely contributed in
making known the natural resources of his native country,
This Testimonial was
Presented to
Sir WILLIAM E. LOGAN, Knight, F.R.S., F.G.S., LL.D.,
by many of the inhabitants of Montreal,
desirous of marking their respect and esteem for
one of the most distinguished of
their fellow-citizens.
Montreal, July, 1856.

On the other sides of the pedestal were designs representing the varied vegetation of the Carboniferous period.

Owing to numerous delays, the testimonial did not arrive from London, where it was designed and made, until August, 1858. Sir William being then absent in the field, the presentation was necessarily postponed, and did not take place till some time in March, 1859 The Hon. George Moffatt presided on the occasion, and the Right Rev. the Lord Bishop of Montreal acted as the representative of the Committee of the subscribers, and in the name of the citizens presented their gift to Sir William, whom he addressed in graceful terms of congratulation.

In acknowledging the gift, Sir William said:—

"It is a great satisfaction to me that I should receive

from so many of the inhabitants of my native city so distinguished a mark of their regard and approbation, and that it should come through the hands of so eminent and respected a citizen as your Lordship, and in the Hall of the Natural History Society, whose members have already bestowed on me the highest honour within their power. If in the Exhibitions of London and Paris I was any way instrumental in extending a knowledge of the material resources of Canada, it was chiefly of those more immediately connected with the geological investigation with which I am charged. In respect to other materials, my exertions, I fear, would have been of little avail, without the practical experience of those associated with me in the management of the Canadian contributions. Those exhibitions involved a very practical purpose, and seeing that what may be called mineral manufactures had extended but little in this country, I rejoiced in the opportunity offered of placing before the eyes of European judges some of the results of the Geological Survey, persuaded that although we could not show that we possessed the skill requisite to give all our metallic ores and useful rocks the various ultimate forms of which they were capable, we should at least convince the world that Canada contained in her subsoil vast stores of mineral materials that would hereafter become available for the support of native industry. The mere specimens exhibited, however, would have been an ineffectual means of attaining the object had they not been accompanied by a geological map showing that geographical distribution of the formations from which the minerals were

derived—thus making at once intelligible the position and abundance of those things of which the specimens merely displayed the nature. Successful, however, as our geological contribution proved to be, there was one branch of the subject in which we were deficient: our fossils had not been arranged or described, and it was, in consequence, impossible for us to prove the sequence of our rocks from their position, except by an assertion that was not disputed. I am not myself a naturalist, to describe fossils. For many years of my life engaged in the active pursuits of a practical miner for coal, and a practical smelter of copper from its ores, my connection with geology relates more to the application of materials. But I well know the value of fossils as an indispensable means of research, and unless Canadian fossils are properly described, Canadians will never thoroughly understand their own economic minerals, or even sufficiently know them to protect themselves from imposition; nor will the study of Canadian minerals enter into the educational systems of the country. In the form given to the testimonial which you do me the honour to present to me, it is gratifying to me to observe typified a discovery which, in my pursuit as practical collier, I was so fortunate as to make, by which coal and its associated fossils were drawn into closer relation than had ever been known before. By it the practical researches for coal were greatly facilitated; and, as a practical collier, I can assure you that it is only in a knowledge of the differences that exist between such kinds of fossils as this testimonial indicates, and others of a distinct description of organisms,

that you have the most certain means of discriminating between the coal of Newcastle and that of Bowmanville. One pleasing circumstance that attaches to this testimonial is, that amongst those presenting it there are so many engaged in the practical business pursuits of life. It gives me an assurance that they are convinced of the usefulness of geological investigations; and I beg to assure you that, as marking the good-will of so many of my fellow-citizens, I shall always regard it with feelings of satisfaction and pride."

CHAPTER XV

AMERICAN ASSOCIATION.—LAURENTIAN.—QUEBEC GROUP

EARLY in 1856 the idea suggested itself to some of the members of the Montreal Natural History Society of inviting the American Association for the Advancement of Science to cross the boundary and hold its eleventh meeting in the following year on British soil. The idea was, to say the least, a bold one, considering the small number of scientific devotees to be found in the commercial city of Montreal. There were those, moreover, who said "that the American members would never consent to the association assembling on this side the line of 45°, and it was strongly urged, certainly with more of truth than poetry in the argument, that for the Natural History Society, a paralysed, helpless, and almost hopeless institution, struggling hard for its very existence, to invite an association so active and energetic, so distinguished and so full of vitality, would not only be a shock to modesty, but a proceeding which, if favourably received, would place the society

in the most awkward difficulty of providing ways and means in accordance with its obligations to accommodate and entertain the association so invited."

This was the opinion of a few, but they were soon silenced, and it was resolved to send a deputation to the Albany meeting in 1856, fully empowered to invite the Association to hold its next meeting at Montreal, in August, 1857. But the Montreal delegates found that they were not the only ones in the field, for Baltimore had sent a worthy representative, who strongly urged the claims of his city. The permanent committee declined to decide between the opposing claimants, but the question being put to the Association at large, the meeting gave its voice in favour of Montreal.

The labour entailed in making preparations for such a gathering can only be understood by those who have had the work to do. A local committee, composed of many of Montreal's most influential citizens, was appointed, with Sir William Logan as chairman, and everything was done to ensure a successful meeting. The Canadian Government contributed £500 to assist in the celebration, and Sir Edmund Head, the Governor, took a most lively interest in the undertaking. Owing to absence in England he was prevented from taking part in the proceedings, and the duty of welcoming the Association to the Province devolved upon Sir William Eyre, the temporary administrator of the Government.

Logan's duties in connection with the exhibitions of London and Paris had sadly interfered with the progress of the museum on St. Gabriel Street,

and now the approaching advent of so many men of science to Montreal, made him feel that if the results of his geological work were to be understood or appreciated, it would be absolutely necessary to have his large geological collections displayed to the best advantage. From the very commencement of the Survey he had been obliged to depend almost wholly upon outside aid for the determination and description of fossils. He had, however, long felt that if the Survey was to make proper progress, it would be absolutely necessary that a skilful palæontologist should be added to the staff. For several years prior to 1856 he had kept up a correspondence with the late Mr. Elkanah Billings, then a resident of Bytown By profession a barrister, Billings had gradually become so enamoured of the study of natural history as to finally abandon the legal calling and devote himself exclusively to the pursuit of science. On the 29th. of February, 1856, he wrote to Sir William: "I have abandoned my profession and intend to devote the rest of my life to the study of natural history. I have commenced the publication of this magazine partly as a means of subsistence, and partly for the purpose of arousing, if possible, the youth of this country to pursuits for which they have everywhere most unrivalled facilities. I am well aware that I shall have great difficulties to encounter, but I can overcome them as I have done others." The magazine to which Mr. Billings alludes was of course the "Canadian Naturalist," of which he was not only the originator, but also, during the first year of its existence, the proprietor and

editor. Most of his time for several years had been devoted to the collection of the organic remains of the Lower Silurian rocks near Bytown, and he had in 1854 published a paper in the Journal of the Canadian Institute of Toronto, "On some genera and species of Cystidea from the Toronto limestone." Altogether Sir William felt that the Survey would be greatly strengthened if he could secure the services of Mr. Billings; and accordingly on the 7th of June, 1856, he addressed a letter to the Provincial Secretary, strongly urging his appointment. Fortunately the recommendation was approved of, and in the following August Mr. Billings took up his residence in Montreal, and began his duties as palæontologist to the Survey, a post which he most ably filled for twenty years.*

In the present emergency his services were invaluable to Logan, and the immediate naming and classification of a large proportion of the Government collection of fossils was rendered possible. Sir William himself worked early and late at the museum, and by the time of the meeting of the Association everything was in excellent order, and the collection attracted much attention. One of the principal objects of attraction in the city," says a writer in Silliman's Journal, "was the Geological Museum, containing the collections made in the course of this survey. It was remarkable for the extent and variety of rock specimens, and the great number and beauty of the fossils; no geological survey

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* For the above facts concerning Mr. Billings the writer is indebted to an excellent obituary notice from the pen of Mr. J. F. Whiteaves, F.G.S., published in the *Can. Nat.*, Ser. 2, Vol. viii., p. 251.

on this or any other continent has been carried forward with greater energy or skill."

At the meeting the Geological Society of London was represented by Professor (now Sir A. C.) Ramsay, the Linnean Society by Dr. Berthol Seaman, and the physical science of Great Britain by Professor Kelland, of Edinburgh. Sir William Hooker and Sir Roderick Murchison were both expected, but to the regret of all concerned it proved impossible for them to come. Murchison was intensely desirous of visiting America, but seems to have dreaded the heat of Montreal in August.

"London, *April* 12*th.*, 1857.

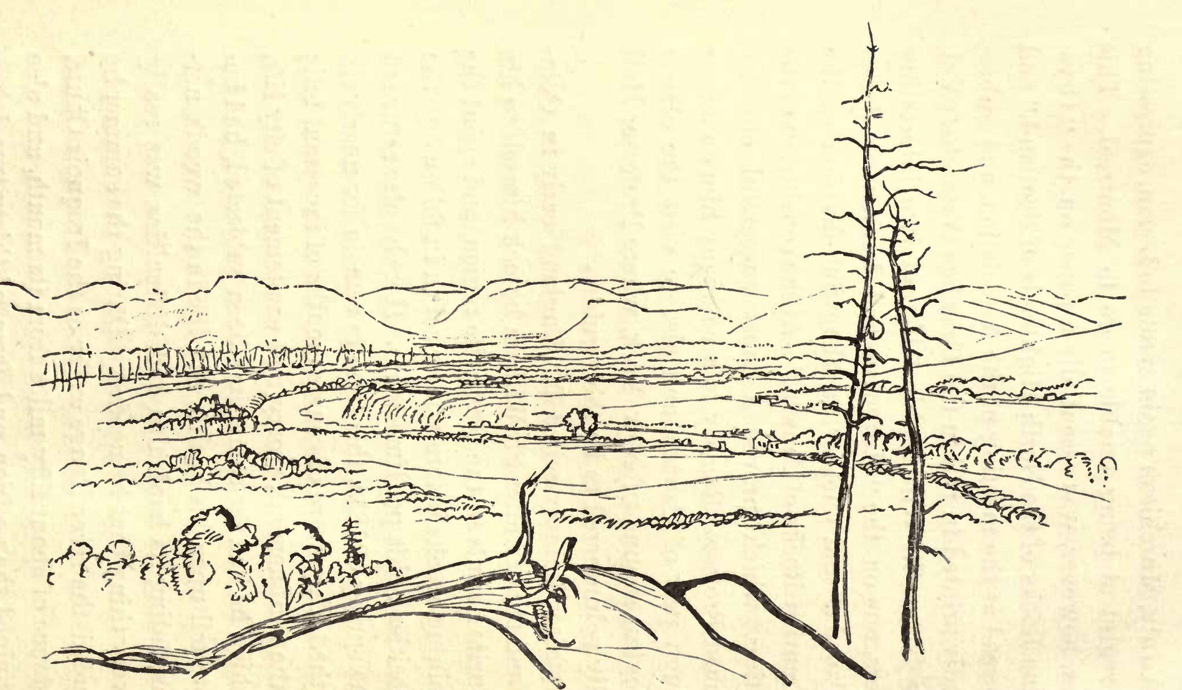
"My Dear Logan,—This letter will be delivered to you by Mr. Gould, the celebrated ornithologist, who, accompanied by his son, is just setting off for a rapid journey through Canada and part of the States. Pray receive them well. . . . I heard of your grand festival which is to come off at Montreal through Ramsay, and almost expected that you would have written to the Old Siluria himself to tempt him with baits of Lower and Upper Silurian—to him irresistible.

"I really have had the strongest yearning to go to North America, and see before I died such a splendid field of my old rocks as the Canadas and the United States afford. But they frighten me about the heat, which they say will be intolerable at Montreal in August. Write to me about it. Ramsay ought certainly to go, whether I can or not. The cry of justice to Ireland will, I fear, compel the Director General to be in the way.—Ever yours sincerely,

"Roderick I. Murchison."

In July, Murchison again wrote to Logan, expressing his regret at being unable to go to Montreal. This letter, however, was essentially a paper on the "Crystalline Rocks of the North Highlands of Scotland," and was read at the meeting of the Association, and subsequently printed in full in the *Canadian Naturalist* (Vol. ii., p. 262). Sir William himself read two interesting papers, one on the "Huronian and Laurentian Series of Canada," and another on the "Sub-division of the Laurentian Rocks of Canada." At the conclusion of the meeting, which proved a most successful one, he induced Professor Ramsay to accompany him on a tour through part of Canada, and also to visit the classic geological ground of New York, where Professor Hall kindly volunteered to be their guide

Professor Ramsay sailed for England early in October, and shortly after Sir William betook himself to his favourite haunts in the Grenville region, and spent the remaining weeks before winter set in in following the sinuosities of his pet limestones. Here he also returned in the spring of 1858, this time to remain for nearly six months. They were of course months of incessant toil; but the confinement, worry, and excitement of city life, to which he had for some time been subjected, had begun to tell upon his health, and life in the woods, notwithstanding its hardships and difficulties, was really the very thing that he needed. During the summer he ascended the river Rouge as far as the Iroquois Chute, a distance of about fifty miles from its mouth, and also determined the position and form of thirty-two lakes, the largest of which is more than six miles in length.



Hamilton's Farm on the River Rouge.—The Laurentides, with their rounded outlines, are seen in the distance.
Note Book, 1858

He was accompanied by a naturalist, Mr. W. M. S. D'Urban, who made large collections illustrative of the fauna and flora of the district examined. The late Mr. James Lowe, a farmer from the township of Grenville, also proved of great assistance to him, and acquired such skill in geological field work that Sir William employed him for years in tracing out bands of crystalline limestone.

It was the end of November before Logan got back to Montreal, and for the next three months he was constantly occupied with the accounts of the Survey expenditure, which he had annually to submit to the Government. In March, as we have seen, the testimonial from the citizens was presented to him. On the 18th of April he wrote to his brother Edmond : "I am sorry to say that the Government have found themselves under the necessity of reducing the grant to the Geological Survey to one-half the usual amount, making it £2,500 instead of £5,000. The sum will be no more than sufficient to pay the salaries of the staff and keep up the museum. It will allow nothing for exploration; so that we have been instructed to stay at home and work out a condensation of all our reports, and thus show the present condition of Canadian geology. I fear that the confinement this will entail upon me will be prejudicial to my health, which is not so strong as it used to be. I found that my summer's work last season did me a world of good, and another summer's work would, I think, have brought me round altogether. I have never been perfectly well since I was at Paris. . . . By way of exercise I fancy I shall have to take

an occasional week of exploration at my own expense."

In August he attended the meeting of the American Association at Springfield, and had the pleasure of renewing many of the acquaintances which he had formed at the Montreal meeting. He exhibited a map showing the distribution of some of the crystalline limestones of the Grenville region, and also specimens of a supposed Laurentian fossil from Calumet Falls on the Upper Ottawa.

Although we have already repeatedly referred to the work in connection with the Laurentian rocks which for years occupied so large a share of Sir William's attention, a somewhat more connected statement may not be out of place here. In the preliminary report which he addressed to the Governor-General in December 1842, he notices in general terms the different formations known to exist in Canada, and among others a great formation of syenitic gneiss occupying the hilly country on the north side of the St. Lawrence, underlying the fossiliferous Silurian rocks.* He traces these rocks from Cape Tourmente below Quebec to the banks of the Ottawa, thence to the Thousand Islands, notices their extension northward into the mountains west of Lake Champlain, and follows them westward to the north shore of Lake Superior. He distinctly recognizes the fact that the flat Silurian beds rest on the irregular surfaces of these older crystalline rocks, which he designates by the general term *Primary*. Thus at the commencement of his work in Canada, he was aware of the

* In the report he refers to the Laurentide hills as "Syenitic hills of a gneissoid order."

existence of that great formation which was subsequently named the *Laurentian*, and would appear to have examined its contact with the Silurian formations in many places.

Ten years before the time of which we write, Eaton, of the New York Survey, had described the Primary gneisses of the Adirondack hills, and as early as 1827 Dr. Bigsby had noticed the ancient gneiss underlying the Silurian limestones at Beauport, near Quebec. To the labours of Bigsby, and to other Canadian researches before the institution of the Survey, Logan refers in his preliminary report as follows: "The labours of Captain Bayfield, of Dr. Bigsby, Captain Baddeley, Dr. Wilson, Mr. Green, and others, show that the Primary rocks form a continuous line from one end to the other of northern Canada. They constitute the northern shore of Lake Superior, and that of Huron, and coasting along the north margin of the great transition trough described, they reach Cape Tourmente, whence they form the north shore of the St. Lawrence and run along the coast of Labrador."

In the Report of Progress for 1843, little is added to our knowledge of these rocks; but Murray, who had met them in his explorations north of Lake Simcoe and on the north-eastern shores of Lake Huron, recognized in some of them a bedded character, from which he infers that they are "metamorphic" rocks.

In 1845, as already stated, Logan explored the Ottawa River and some of its tributaries to a distance of 250 miles above Bytown, while in the following year both he and Murray examined the north shore of Lake Supe-

rior. The reports on the work of these years for the first time accurately define and describe the great Laurentian (lower) series, to which so much time and study were afterwards devoted.

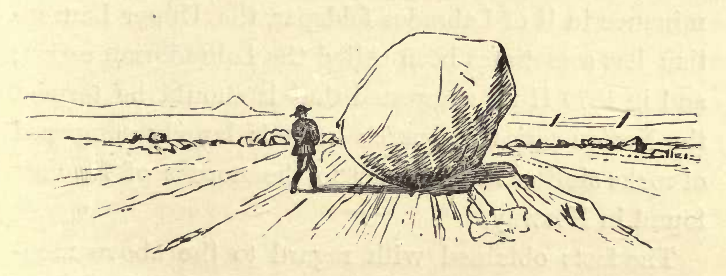
In the Report for 1845, which was presented to the Government in May 1846 and published in 1847, Logan adopts for these strata the term metamorphic as employed by Lyell. They were described as of great thickness, usually highly inclined and much contorted, and as consisting of a lower group, entirely gneissose, and an upper group containing crystalline limestones. On page 40 of his report, speaking of an anticlinal arch crossed by the Ottawa near the Mattawa River he says: "The lowest rocks which this undulation brings to the surface are of a highly crystalline quality, belonging to the order which in the nomenclature of Lyell is called metamorphic instead of primary, as possessing an aspect inducing a theoretic belief that they may be ancient sedimentary formations in an altered condition. Their general character is that of a syenitic gneiss. Their general colour is reddish, and it arises from the presence of reddish feldspar, which is the prevailing constituent mineral. The feldspar, however, is often white, and frequently of a bluish-grey. The rock is in no case that I have seen without quartz. Hornblende is seldom absent, and mica very often present. The prevailing colour of the quartz is white, but it is often transparent or translucent. The hornblende is usually black, and sometimes green. The mica is often black, frequently brown, and generally of a dark tinge. The rock (carefully distinguished from dykes) is almost

universally small grained, and though the constituent minerals are arranged in parallel layers, no one constituent so monopolises any layer as to exclude the presence of others; but even in their subordinate arrangement there is an observable tendency to parallelism. A thick bed of reddish feldspathic rock, for example, will in section present a number of short dashes of black hornblende or black mica, all drawn in one direction, destitute of arrangement apparently, except in regard to their parallelism; or it will be marked by parallel dotted lines composed of these minerals. The continuation of these lines will be interrupted irregularly, and before one ends another will commence above or below it, the lines interlocking among one another. Sometimes thin continuous parallel black belts will run in the rock for considerable distances; or it will be barred by parallel streaks of white quartz or white feldspar, in which, as well as the red part, these dotted lines will occur. The same description of arrangement will be found where the whole ground of the rock is white instead of red, and then the red feldspar will occasionally constitute streaks. There is no end to the diversity of the arrangement in which the minerals and colours will be observed, but there is a never-failing constancy in respect to their parallelism." From this extract it will be seen that it was not only the broad details of stratigraphy that attracted Logan's attention, but that he also carefully studied many of the minuter structures with which all students of the Laurentian rocks are now familiar. On page 41 of the same report, he continues: "To the south of the Mat-

tawa and of the Ottawa in its continuation after the junction of the two streams, important beds of crystalline limestone become interstratified with the syenitic gneiss, and their presence constitutes so marked a character that it appears to me expedient to consider the mass to which they belong as a separate group of metamorphic strata, supposed from their geographical position and general attitude to overlie the previous rocks conformably. The limestone beds appear to be fewer at the bottom than at the top of the group, but whether few or many, they are always separated by beds of gneiss which in no way differs either in constituent quality or diversity of arrangement from the gneiss lower down, except in regard to the presence of accidental minerals, the most common of which are garnets." Then follow other interesting details concerning the limestones and the minerals observed in them, and a detailed section of 1351 feet of strata, measured near the High Falls on the Madawaska River, as affording a good example of the alternation of limestone and gneiss. Among the rocks met with on Lake Temiscamang in 1845 was a series of hard slates and slaty conglomerates, the latter containing pebbles, and even boulders as much as a foot in diameter, of the subjacent gneisses. It was quite evident that these beds were more recent than the gneissic series, but Logan could detect no evidence of unconformability. Speaking of the slates in his report, he says: "It appears probable they will come upon some part of the north shore of Lake Huron." This view was subsequently verified, and through the labours of Murray the

Huronian system established. According to the observations of the latter, north of Lake Huron, the series there attains a thickness of 18,000 feet, and gives good evidence of being uncomformable to the underlying Laurentian.*

Subsequently, as has been stated, a series of surveys of portions of the Laurentian districts, especially in the neighbourhood of the River Ottawa, was continued, and in these researches several members of the staff took an important part. For a long time great quantities of erratic masses of a rock composed largely of labrador



AN ERRATIC, SKETCHED BY LOGAN

feldspar were known to exist in the valley of the St. Lawrence; and in 1852 it was discovered *in situ* by Logan in the townships of Morin and Abercrombie, and described by Hunt in his official report for that year. Subsequently the rock was shown to belong to a great stratified series resting unconformably upon the Laurentian gneiss. It was hence called by Sir William

* As early as 1824, the Huronian rocks of Lake Superior had been described by Bigsby and classed by him with "Transition rocks." The name Huronian was first used in the "Esquisse Geologique du Canda," a little volume prepared by Logan and Hunt for the Paris Exposition of 1855.

the Upper Laurentian series, and was believed by him to intervene between the Lower Laurentian and the Huronian, although nowhere found in juxtaposition with the latter. We have already seen that the Laurentian as originally described includes a lower group of gneisses without limestones, to which succeeds a group of gneisses and interstratified limestones. These two groups together constitute the Lower Laurentian of Logan; but inasmuch as the upper division might be confounded with the Upper Laurentian proper, it has sometimes been termed Middle Laurentian. Owing to the occurrence of the series in Labrador, and the predominance in it of Labrador feldspar, the Upper Laurentian has sometimes been called the Labradorian series; and in 1870 Hunt suggested that it should be termed the Norian series, inasmuch as it is largely composed of rocks similar in character to the norites of Esmark found in Norway.

The facts obtained with regard to the above mentioned groups previously to 1863, by Logan, Hunt, and other members of the staff, were summed up in the *Geology of Canada*, and the rocks there described may be tabulated at follows:—

		FEET.
1. Lower Laurentian or Ottawa Series.	Gneiss of Trembling Mountain, &c......	5,000 ?
2. Middle Laurentian or Grenville Series.	Trembling Lake limestone.............	1,500
	2nd. Orthoclase gneiss	4,000
	Green Lake limestone, bands of gneiss, &c.	2,500
	3rd. Orthoclase gneiss	3,500
	Grenville limestone, bands of gneiss, &c..	750
	4th. Orthoclase gneiss, including a thin bed of limestone and a bed of quartzite.	5,000
3. Upper Laurentian (Labradorian, Norian.)	Anorthosite rocks, limestone, and gneiss.	10,000 ?
4. Huronian.	Conglomerates, chloritic and other schists, limestone, &c......................	18,000

The above expresses in general terms the arrangement of these rocks as described in the *Geology of Canada,* and the maps and sections accompanying the volume. More recently certain rocks in Eastern Ontario which have been surveyed by Mr. Vennor, and which have been regarded as less altered portions of the Laurentian, have been described as a newer series, and provisionally termed the Hastings series.*

The labour involved in working out these results can be appreciated only by those who have had opportunities to study in the field the contorted strata of the Laurentian country, and though Logan had in the pro-

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* The rocks of the Hastings series were first examined by Mr. Murray, who in his report for 1852 (p. 103) remarks that, "In Huntingdon, Madoc, Marmora, and Belmont, many interesting diversities occur in the Laurentian series, but the rocks belonging to it become so frequently and unexpectedly covered up by projecting and outlying masses of the unconformable fossiliferous formations, in the part investigated, that it is impossible to give any connected view of their arrangement." In 1864 Mr. Thomas Macfarlane studied the rocks of this interesting region, which he described in a report addressed to Sir William Logan (1863-66). He there called attention to the similarity of the schistose conglomerates of Madoc to conglomerates of Huronian age. In a foot-note to page 93 of Mr. Macfarlane's report, Sir William states his opinion with regard to the Hastings series as follows:—"The rocks of Marmora, Madoc, and other townships in Hastings, have provisionally been classed with the Laurentian series, with which they appear to be conformable, and in common with which they hold *Eozoon Canadense*. . . . These Hastings rocks may be a higher portion of the Lower Laurentian series than we have met with elsewhere. It is not to be inferred from the presence in them of a schistose conglomerate that therefore they are Huronian. As shown in the *Geology of Canada*, p. 31, conglomerates occur in the Laurentian, as well as the Huronian series. Some may be disposed to compare the Hastings rocks with the metamorphic Lower Silurian of Eastern Canada, but the micaceous limestones of Hastings more closely resemble the micaceous limestones which run from Eastern Canada into Vermont, on the east side of the Green Mountains, and which, from their fossils, are known to be Devonian. . . ." According to Dr. Hunt, the rocks referred to here are not Devonian, but Lower Taconic, and it is to this horizon that he refers the Hastings series.

secution of his researches the advantage of public funds, and of a corps of able and willing assistants, his own personal share in these arduous surveys, and in the hardships which they entailed was always large. Farther, there can be no doubt that the unravelling of the intricate distribution of the rocks so as to enable them to be intelligently mapped and described was in the main due to his remarkable and clear insight into difficult questions of this kind. To geologists it is unnecessary to add that Sir William's reports and memoirs have made Canada the classical ground of the *Eozoic rocks.*

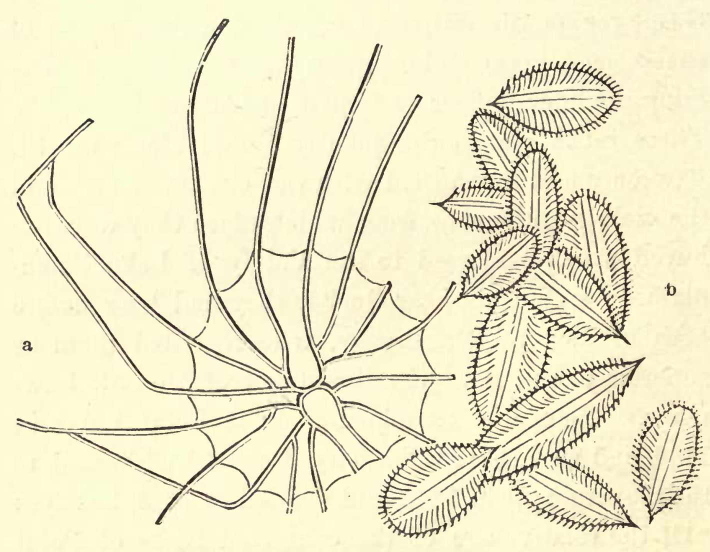


CONTORTED GNEISS BANDS IN LIMESTONE. Scale about $\frac{1}{40}$.
l, *l*. Limestone including thin layers of Gneiss. *g*, *g*. Gneiss above and below Limestone. *Geology of Canada*, p. 27.

The years 1860 and 1861 seem to have been most uneventful for Sir William, and he remained most of the time in Montreal, attending among other matters to the preparation of his great work on the geology of Canada. From time to time, however, he found it necessary to visit some particular point in the country in order to obtain additional facts for the forthcoming

volume. The rocks of the Eastern Townships especially continued to engage his attention, and a few remarks concerning them may be appropriately made here. For fuller discussions of the subject the reader is referred to the appendix (A) to this volume, kindly contributed by Principal Dawson, and to Dr. Hunt's interesting volume on "Azoic Rocks," published in 1878. We have seen that in the course of his examination of the Gaspé region, Sir William recognized a great series of shales, sandstones, and conglomerate limestones, underlying the later Palæozoic formations of the Peninsula These rocks were subsequently traced along the St. Lawrence and indentified with the contorted strata of the vicinity of Quebec, from which place they were followed south-westward to the Valley of Lake Champlain. As occuring near Quebec they had long before been studied by Dr. Bigsby, who regarded them as superior to the flat-lying limestones of the St. Lawrence. Logan first examined them at Point Levis in 1840, and in his "Preliminary Report" addressed to the Government in 1842, and printed in 1845, he says: "Of the relative age of the contorted rocks of Point Levis opposite Quebec, I have not any good evidence, though I am inclined to the opinion that they come out from below the flat limestones of the St. Lawrence. Further study of the matter, however, soon caused him to change his view to that of Dr. Bigsby, and in a footnote added to the above before it was printed he says: "The accumulation of evidence points to the conclusion that the Point Levis rocks are superior to the St. Lawrence Limestones." Such indeed was the conclusion

which any one might have arrived at from a mere study of the stratigraphy, and such was the opinion which Logan held until 1860, the rocks up to that time being referred by him to the Hudson River group. The discovery of graptolites at Point Levis in 1854 only served to confirm him in the view already taken, for both in New York and Sweden, where graptolites



GRAPTOLITES FROM THE QUEBEC GROUP.
a. *Graptolithus Logani* (Hall.) b. *Phyllograptus typus* (Hall.)

of other forms were known, their horizon was the same as that which Logan had assigned to the Point Levis rocks. In 1856, "orthoceratites, trilobites, and other fossils" were discovered in a bed of limestone at Point Levis by Dr. Hunt. This led to a more thorough examination of the locality, and during the next four years large collections of organic remains were made

by Bell, Richardson, and other members of the Survey. They were carefully studied by Billings, who finally arrived at the conclusion that they belonged to rocks much more ancient than the Hudson River formation. This most important and sagacious discovery of Billings obliged Logan to seek for an explanation of the anomalous stratigraphical relations. How could it be that rocks which according to the best of palæontological evidence belonged to the "horizon of the Chazy and Calciferous" were stratigraphically above the Hudson River formation? This was the problem to be solved, and the solution offered by Logan was that the more ancient series had been "brought to the surface by an overturned anticlinal fold, with a crack and a great dislocation running along the summit," by which the older rocks were "brought to overlap the Hudson River formation." The older series Logan now (1860) termed the Quebec group, dividing it at first into two members, the Levis and Sillery formations, to which he assigned a total thickness of from 5,000 to 7,000 feet. Subsequently it was "found convenient" to separate the upper portion of the lower or Levis division, and to this intermediate division the name of Lauzon was applied.

On tracing the rocks of the group under consideration, south-westward from Quebec through the Eastern Townships, they were found in close connection with crystalline strata, the prolongation into Canada of the crystalline schists of Vermont, which, even before the time of Logan, had been the cause of considerable difference of opinion among American geologists.

Eaton and Emmons on the one hand had maintained that they were "Primary," while Mather and others regarded them as altered Palæozoic strata. After studying the stratigraphy of the region occupied by these rocks in eastern Canada, Logan adopted the latter view, and firmly adhered to it during the remainder of his life. The crystalline strata were regarded by him as an "altered" portion of the great series which, as we have seen, previously to the palæontological investigations of Billings had been referred to the Hudson River group, and were accordingly termed in Logan's early reports "altered Hudson River group." But after the uncrystalline strata had been shown to be more ancient than the Trenton, and had been named the Quebec group, the accompanying crystalline rocks in question were denominated "altered Quebec group." This view of the case was generally current among geologists for some years, and has still its supporters, including Mr. Alexander Murray, who has had the best of opportunities for studying the corresponding series of rocks in Newfoundland. In 1862, however, Mr. Thomas Macfarlane drew attention to the similarity of the crystalline strata of the Eastern Townships to the Huronian series of the great lakes, and paralleled both series with the primitive schist formation which he had studied in Norway (*Can. Nat.*, VII., 125). The Huronian age of the series in the Townships has also been maintained by Dr. Hunt, who, to use his own words, "has, for many years, believed that the position of the Sillery sandstone is at the base instead of at the

summit of the Quebec group, and that the whole series is more recent than the crystalline rocks of the Atlantic belt, to which the Notre Dame and Shickshock Mountains, and the similar crystalline rocks in Newfoundland belong" (Azoic Rocks, p. 114). Mr. Selwyn, Sir William's successor, when he first came to Canada adopted the views of his predecessor, but on further study of the matter has changed his opinions, and now believes in the pre-Cambrian age of the rocks under consideration.

CHAPTER XVI.

EXHIBITION OF 1862.—PRECARIOUS EXISTENCE OF THE SURVEY — EOZOON CANADENSE.

SIR William had had quite enough of exhibitions, and would gladly have been left to carry on the work of the Survey and bring to completion the long promised volume on the Geology of Canada. But his success and experience on former occasions now made the Government feel that he, if anyone, should represent Canada at the great International Exhibition to be held in London in 1862. Accordingly he was made Chief Commissioner, while Mr. Brown Chamberlin and Mr. J. B. Hurlburt were associated with him as Assistant Commissioners, to represent Lower and Upper Canada respectively. Before leaving for England a large geological collection had to be brought together, and that hurriedly and under great difficulties, as no instructions were received until the eleventh hour.

Sir William arrived in London on the fifth of April, and not a day too soon, as the space originally allotted to Canada in the Exhibition was on the point of being

given up to others. On the 8th of May he writes to his brother:—"As you may suppose, we have been in a whirl of occupation ever since we came, scarcely knowing whether we were on our heads or our heels. I have been made a Juror in Class I., but I fear the work will be too much for me.

"Although I get up early in the morning and have occasionally been at work at six, I have with great difficulty been able to put my map into shape. I did not get the sheets from Paris until the 15th of April; then I had to get them mounted, and to compile a part of the geological details, reducing them from a larger scale. Altogether I am sick of the work, and wish I were at home again attending to my geological explorations."

On the 29th of May he again writes:—

"I have been so pushed with Jury work and a discussion with Her Majesty's Exhibition Commissioners about our Timber Trophy, that I have not had time to send another set of maps. I wish I were back again in Canada and settled at my regular work . . . . "I wrote to Mr. Galt by the last packet, requesting him to get some of the Commissioners here to assume my place and let me return. I hope he will attend to the matter as the worry is too much for me.

"I have multitudes of invitations to dinners, soirees and conversaziones, but I avoid all I can. There was an 'athome' at the Speaker's last night, for which a card was sent to me, but I did not go. This evening there is a dinner at the Duke of Newcastle's, to which I must go. On Tuesday there was an anniversary geographical dinner. Sir Roderick Murchison was Chairman, and I

was called upon to reply to a toast . . . . The Hudson's Bay Company have invited me to a dinner at Gravesend, but I have not accepted. Lady Goldsmith gives an 'at home,' Lord Granville a déjeuner, and the Lord and Lady Mayor and Mayoress have sent me an invitation; but all these I shall decline. Then there is to be a soiree at the Royal Society, but I am not sure whether I shall go or not. Of other entertainments there are multitudes, but I am sick and tired of all such hubbub."

Altogether he was in a most discontented frame of mind, and the one thing in London which seems to have afforded him any real satisfaction was the daily reunion at the house of his sister, Mrs. Stewart, on Cambridge Square, where a "jolly party of twelve" sat down to dinner every day. One source of great anxiety was the news which reached him of a political crisis in Canada, which he thought might have a detrimental effect upon the interests of the Survey. On the 2nd of May the Cartier-McDonald Ministry had been defeated on the Militia bill, and now Logan feared that the new Finance Minister might not be as favourably disposed towards the Survey as Mr. Galt had been. His work as a Juror was finished in June, and shortly after the much longed for permission to return to Canada arrived, and was gladly taken advantage of.

As one of the evidences of the high opinion entertained in England at this time with regard to Sir William and his work, we give an extract from an article by Dr. Percy, of London, in *The Times* of July 24th, 1862. The article was one of a long series by Dr. Percy on the metallurgical collections of the Exhibition of that year.

For the extract we are indebted to its writer, who in sending it says:—"It may interest you, as it is a sketch of the work of Sir William Logan, whom I knew well and respected greatly."

"Canada is most worthily represented in Class I., thanks to the director of the Canadian Geological Survey, Sir William Logan. Justice compels us to deviate from the course we have hitherto pursued, and bestow more than a passing notice on this indefatigable geologist. Unaided, he commenced, in 1831, a geological survey of part of the great South Welsh Coalfield extending from Crown Avon to Carmarthen Bay, and completed it in seven years, at no small pecuniary sacrifice. Such was the estimate of the accuracy and value of this survey by the late director of the Geological Survey of Great Britain, Sir Henry De La Beche, that with Sir William's consent, it was adopted as part of the national work. In 1842 Sir William went to Canada, where he has ever since resided, devoting his life with singleness and earnestness of purpose truly remarkable, to the exploration of the structure and the mineral resources of that vast territory. Not having the advantage of an accurate map of the country, such as has been supplied to our home geologists by the Ordnance Survey, he has been obliged to make a topographical survey *pari passu* with a geological one. Few persons can imagine the arduous nature of this work. Our indomitable geologist is often compelled to penetrate the trackless primeval forest, to force his way across the tangled cedar swamp, and brave the dangers of Canadian Rapids in a frail canoe; and to these difficulties we may add that his

path is disputed at every step by the most relentless and invincible foes with which man in these regions has to contend—countless hosts of mosquitoes and black flies. Very different is the comparatively light and gentleman-like occupation of our home geologists, who have no such hardships to encounter, and, after the pleasant ramble of the day, never fail to enjoy the luxury of an English cottage. Sir William Logan has neither sought wealth nor honours, but has quietly and modestly pursued the one great object of his life, with a devotion as rare as it is praiseworthy. Let it not be supposed that this eulogium is prompted by any feeling of personal regard. It is a just tribute, and no more, to a man who has striven during many years to develope the vast mineral resources of Canada, not with a view to his own advantage, but from pure love of his work. We are glad to know that the Canadian Government fully appreciate the value of the labours of this self-denying and faithful public servant. The Canadian territory comprises about 300,000 square miles, and about 100,000 have already been surveyed by Sir William and his small staff of assistants."

After Logan's return to Montreal in August, he took up the broken thread of work in connection with the preparation of the *Geology of Canada*, and now and then visited some locality in the country in order to obtain additional information. In the autumn of the following year (1863) the long expected volume appeared. It was more than eight years since its preparation had been ordered by Government, and many thought that its publication ought not to have been so long deferred. But neither the country nor science lost anything by

the delay; for the volume was not a mere summary of the earlier reports of the Survey, but a new book containing all the earliest facts concerning the geology of the country. The work is too well known to require any lengthy comment here, but it may be stated that although published nearly twenty years ago, it remains to-day the most valuable book of reference on the geology and mineralogy of the provinces of Ontario and Quebec. Clear, sufficiently full and not overburdened with details, accurate in its descriptions and wonderfully free from typographical errors, the purely scientific portion evenly balanced by a proper allowance of economic geology, it was altogether a model report.* Nor did it fail to attract its meed of commendation on both sides of the Atlantic. "The style in which this work has been got up," says the *Saturday Review*, "the precision of the drawing, and the accuracy of the woodcuts, may almost challenge comparison with the execution of similar productions on this side of the Atlantic. There has been a steady persistence in the conduct of this remarkable Survey, honourable alike to the successive Governments that have encouraged it, and to the officers who have carried out the work. No other Colonial Survey has ever yet assumed the same truly national character; and the day may come--if ever the 'Imperial Colony' shall claim and obtain independence—when the scien-

* It is but fair to state that although the *Geology of Canada* is commonly known as "Logan's great work," a large portion of it came directly from the pen of Dr. Hunt. This was true, for example, of the lithological part of the volume and of that on economic geology, comprising together no less than 380 pages. The proofs of the entire volume also passed through his hands.

tific public of a great nation, looking back upon the earlier dawnings of science in their land, shall regard the name of Logan, native born, with the same affectionate interest with which English geologists now regard the names of our great geological map-makers, William Smith and De La Beche."

At home the work did not meet with universal approbation, on account of the large share of attention given to fossils. The Prime Minister even went so far as to express his opinion in Parliament that instead of the Report being what it was, "it ought to have been a school-book to instruct the youth of the Province in the elements of geology." For this he was ridiculed not a little by some of Logan's friends, and one witty Irish orator explained that the Prime Minister objected to the investigation of fossils, because it was "carrying personalities too far".

After the distribution of the Report, Sir William received numerous letters of acknowledgment from scientific men, all in terms of the warmest friendship and admiration. One of these we give here, as it is an interesting and touching souvenir of the declining years of a man who long played an important part in the world of science, and whose kindly nature endeared him to all who knew him:—

"LONDON, ROYAL INSTITUTION,
"*4th. April*, 1864.

"MY DEAR SIR WILLIAM,—I received a few days since, by the kindness of Lord Monck, the copy of your great work the *Geological Survey of Canada.* It called up in my mind the many and strong impressions which

yet remain there associated with your figure, character, and personality;—received at the time of the great Exhibition in 1851. How the lapse of time since then has changed things, *i.e.*, how it has changed me; and in my change it is quite a happiness to be thrown back a while upon the recollections of the past. For they are very pleasant to me, and I thank you most earnestly for such a reminder.

"I am getting somewhat old and my hand refuses to carry the pen over the paper as steadily and freely as it used to do: but here I am still surrounded by the kindness and love of all my friends. Tyndall, Frankland, Dr. Bence Jones and many others comfort me continually. Discovery has come to an end with me, save that I rejoice in the discovery of others; and indeed knowledge is progressing wonderfully.

"I wish I knew more of geology than I do, but my memory is gone, and I never had the opportunity of observing in the fields the valleys and the mountains. I hear of you continually from the men I most value.—Ever my dear Sir William, yours most truly,

"M. Faraday."

For several years the Survey had depended upon an insufficient annual grant for its precarious existence, and its operations had been greatly hampered. No Survey could, in fact, be properly conducted on such hand to mouth principles. Accordingly Sir William addressed a most pathethic appeal to the Hon. Luther H. Holton, then Minister of Finance under the McDonald-Dorion administration, urging upon him in the strongest terms

the necessity of more liberal action on the part of the Government. A portion of the letter is reproduced here, as it gives an idea, in his own words, of some of the uncertainties and harassing difficulties with which Sir William had to contend. His appeal, as we have said, was sent to the Finance Minister; but at the same time he had little faith that it would accomplish much; for a few days after he wrote to a friend: "The present administration is before the country as a saving one, and I think our Survey will get a black eye."

"GEOLOGICAL SURVEY OFFICE,
"MONTREAL, *9th. January*, 1864.

"DEAR SIR,—As all Government matters relating to finance must of course come under your revision, I am induced to address you on the subject of the Geological Survey. The fund provided for its maintenance for the year 1863 is exhausted, and it is desirable that I should be informed, as soon as convenient, as to the future action of the administration in regard to it; as those dependent on the Survey for subsistence are naturally anxious that I should give them timely notice whether or not their services may be required.

"In 1855 an act was passed establishing the Survey for five years, and granting for its support $20,000 per annum. $8,000 were also voted for the publication of a Geological Map and condensed Report. A map on the scale of twenty-five miles to an inch was constructed from the various published maps of Canada, and the neighbouring parts of the United States; but from inaccuracies in some of these, the result was found to be so unsatisfactory, that it was determined to compile the

topography from original Surveys, establishing by telegraph the longitudes of several principal points. To carry this into effect required some time, and in the meanwhile the Survey was conducted on a scale commensurate with the grant. In 1861 the new map was ready for engraving, and at the meeting of the legislature for that year, the fund for the publication of it and the Reports still remained intact; but the act supporting the Survey having expired, the Government instead of placing $20,000 in the estimates for the Survey as previously, deemed it expedient to make $11,000, composed of the fund reserved for the purposes of publication and $3,000 which had been saved, a part of the annual grant, adding $9,000 to complete the usual sum. I was given to understand that it was the intention of the then existing administration to renew the geological act the subsequent session, and it was hoped that during the five years of life thus to be given to the investigation, sufficient might be saved from the expenses of exploration to defray those of publication. By the Honourable Mr. Howland's supply bill, $5,000 of the publication fund was restored to the Survey in 1862; but the general grant was reduced by a like sum, so that the real financial condition of the Survey was left as before.

"The Report has now been printed, and the Government having taken 750 copies at cost price, the outlay on it has been paid with the exception of about $1,200; but the maps by which it is to be illustrated have yet to be coloured, and I shall have to cross the Atlantic to get them printed by chromo-lithography. The topographical lines of the large map on the scale of twenty-

five miles to an inch, which is to be a separate work, have been engraved and paid for, and the lettering which is the most expensive part is in progress. All the palæontological publications up to the present time have been paid for, with the exception of the 2nd Decade. This was undertaken in 1854 by Professor Hall of the New York Geological Survey, before the appointment of a palæontologist to the Canadian Survey. But various circumstances have prevented the completion of it until the present time. The engravings are now finished, and the descriptions are in press, so that it will soon be necessary to provide for the cost, which will probably be over $1,500. . . . It will thus be perceived that independent of arrears, the grant of last session would not be sufficient to pay expenses, while nothing is allowed for publication, without which a geological survey would be a dead letter.

"I am very much perplexed to know how any saving can be made. If the artist were dispensed with, it would save $750; but the means of securing and publishing our palæontological discoveries would be sacrificed. The chief reward of a palæontologist worthy of the name, is the publication of his discoveries. An efficient one could not be obtained if these were suppressed, and without a skilful palæontologist great errors might be made in describing the sequence and distribution of formations. For my part I should be unwilling to conduct an important Geological Survey, like that of Canada, without one.

"If the topographical draughtsmen were dispensed with, it would be a saving of $1,000; but the labour of

topographical delineation would in that case fall heavily on myself. The calls upon our time to give information, both verbally and by letter, in respect to economic minerals, are augmenting so fast, that Dr. Hunt and myself often find days in succession pass without being able to do anything else; and I am thus driven to the necessity of working every night until about twelve o'clock to get through the office details required for the proper conduct of the Survey. The consequence is that I have no time to read up in geology, and this I begin to find a serious professional detriment. It will therefore be necessary for me, should the Survey be continued, to employ a competent secretary, if I can find one, at a sacrifice of one-third of my salary, to relieve myself as much as possible from office details; particularly as my health is beginning to fail from over-work.

"Before the geological grant was sufficient to permit the supply of scientific publications, I had furnished the library with about $2,000 worth out of my own funds. I have disbursed also about $2,000 for surveying instruments required for topographical and geological purposes; and the Survey has brought upon me in addition, in various ways, an expenditure of about $4,000, for which I make no claim on the Government. In order to get the Report creditably printed, I found it expedient to advance a further sum of about $3,000 for the purchase of type, and though I expect this sum to be returned, it is nevertheless a present expenditure, and must run the risks of fate. All this outlay would make it inconvenient for me to contribute to the salary of a secretary out of my own funds.

"The only other sums which present themselves for consideration are those connected with exploration. To diminish these to any extent would reduce the Survey to the condition of doing little work with a heavy staff, a predicament which would be satisfactory neither to the public nor myself. How distasteful such a predicament would be to myself will be shown from the fact that the Parliament having been dissolved last spring without granting the supplies, it appeared to me expedient, rather than allow the officers of the staff to receive their salaries in comparative idleness, to carry on the work of the Survey out of my own funds, and at the expiration of the season I found myself upwards of $10,000 in advance. But the discussion which occurred in the house last session on the subject of the Survey, made me most painfully aware of the risks I might by possibility run by such a procedure.

"The professional responsibilities and difficulties of conducting a geological Survey over so large an area as Canada presents are quite sufficient, without being complicated with those of finance. But the minds of those charged with the investigation can never be free from pecuniary anxieties while the support given to the Survey lasts only from year to year, and has to be struggled for every session of Parliament. No good plan of investigation can be formed under such an arrangement, and the officers and explorers on whom I depend, uncertain of continued employment, may be tempted away from me. The peculiar training which they require would make it very difficult to replace them, and though, as you will understand from a reference to the

preface of the late Report, some of them are not highly paid men, they are all from their practice very valuable.

"Whatever the grant may be, it should be secured for a term of years by an act. But if this is not considered expedient, and the public finances cannot afford a sum sufficient to ensure a Survey creditable to the country and to those charged with it, instead of such a reduction as will just cause it to be inefficient, it would be much better to dispense with the paid services of all the officers of the staff with the exception of the palæontologist. Should the work of exploration be wholly suspended, it will be necessary to support the museum. For the purposes to which it is devoted, it is unrivalled by any on this Continent, and to permit its extinction would in my mind be a national calamity. Properly supported, it will be the means of giving a right direction to all the more detailed geological investigations of the country, both public and private, that may hereafter be undertaken, and with a moderate annual outlay it could be gradually very much extended and improved. A large part of the palæontological materials that have already been collected, have still to be studied and described. If our present palæontologist were appointed curator to the museum, he could by degrees work out these materials as well as anything additional resulting from further explorations.

"Whatever may happen to the Survey it is not my intention to abandon the geological investigation of Canada. The provincial museum would be a very convenient workshop in which to elaborate my results, and any materials that might be derived from my explora-

tions I should be happy to contribute to the provincial collection. If the Government were disposed to permit the employment of two of the less expensive explorers, I should be willing to direct their investigations as heretofore, but as unpaid commissioner, receiving no allowance except for travelling expenses actually incurred on Canadian work, and to give the results of their investigations as well as my own in an occasional report, in furnishing which to the Government I should be permitted to choose my own time. . . .

"Should this arrangement be entertained by the Government, it must be kept in mind that to secure the work of last season's explorations by reducing them to form and reporting, it will be necessary to continue the Survey on its present scale until the spring, and that arrears for work done and responsibilities for publications undertaken will have to be provided for.

"If anything I have stated is not clearly understood, Mr. Langton the Auditor-General, to whose enlightened exertions while he was in the Legislature, the country is greatly indebted for whatever has been done in Canadian geology, will be able to give you full explanations, or I shall be ready to go to Quebec if required.—I am, dear Sir, very respectfully and truly yours,

"W. E. LOGAN.

"The Honble. L. H. Holton, M.P.P.,
"Minister of Finance,
"Quebec."

Not long after this letter was written a change of Ministry occurred, the Conservatives again coming into power, and Mr. Galt, who had always been a warm

supporter of the Survey, being reinstated as Finance Minister. It was proposed by the new Government to renew the act making provision for the Survey, for a period of five years; but the "anti-Silurian nonsense" members were strongly opposed to pledging the country to the five years An animated discussion of two hours' duration took place, which was on the whole highly complimentary to the Survey, and when the question of the five years grant was put to the house a large majority voted in its favour. This was on the 8th of June.

In his letter to Mr. Holton, Sir William alludes to the amount of his own and Dr. Hunt's time consumed in giving information about the economic minerals of the country; and many indeed were the applications or *demands* which were sent, often couched in anything but graceful terms. The letter of one applicant may be given as a sample. A Mr. F——, residing in the country, imagined that he had made a discovery of native lead embedded in cerussite, and sent a box of specimens to Sir William to have his discovery confirmed; but on being informed that the specimens were simply dolomite and contained no lead whatever, he again wrote as follows:—

"C——, *June* 15*th*, 1863.

SIR,—On the first day of June last, I addressed to you by express a box containing about six pounds weight of *ceruse, carbonate of lead*—not calcareous spar. If it was calcareous spar when it reached you it must have been changed on the way. I repeat, I sent you no chalk or lime, or magnesia. When packed into the box and addressed, it consisted of rich samples of *carbonate* of lead,

containing about 60 ounces of silver to the ton of lead. I did not send it to you to have you guess at what it contained. I sent it to you in order to have it assayed to know the percentage of lead and silver which it contained, in order to know how you agree with an assay which I have had made by other persons quite as expert as yourself. That it is what I call it I *know*, and more I know that you, unless more than human, cannot tell the difference between calcareous spar and carbonate of lead by merely looking at it without a test.

"Will you inform me if you saved the samples or not. If not I will procure more, for I intend going to Montreal soon in order to have the ore properly examined. You speak of metallic lead. I said the veins contained small crystals of metallic lead. Perhaps the samples sent contained none; but the different veins contain more or less. In fact small crystals sometimes appear completely surrounded by carbonates. Please send me a line when you get this.

"Hoping that there may be a better understanding,*

"Sir, I remain yours truly,

"——— ———."

Logan was also constantly beset with applicants for employment, and having acquired a reputation for generosity there were never wanting those who looked to him for pecuniary aid. "May it please your Lordship," writes one of the latter, "you will readily see

* On one occasion a man sent a sample of ore to Sir William for analysis and enclosed twenty-five cents in his letter to pay for the work. He was also good enough to state that he had other specimens for examination, and that if the first analysis were satisfactory he would employ Sir William again.

from my petition the unfortunate position I am placed in, and I am led to understand that your Lordship is a benevolent and generous noble man. I shall be happy to have your Lordship head my list of contributors." The letter is addressed to "The Right Honourable Sir W. E. Logan." Another individual to whom Sir William in his unsuspecting way had already given considerable pecuniary assistance, but who had subsequently proved himself utterly unworthy of confidence, finding it useless to apply for more money, makes known his wants thus: "I write to ask you to be kind enough to introduce me to some tailor who will make me a suit of clothes on credit. I find all that I have much too worn and thin for the present season."

Although the text of the *Geology of Canada* had been completed in 1863, neither the atlas by which it was illustrated nor the large geological map of Canada and the neighbouring States were completed, and it became necessary for Sir William to go to London in 1864, in order that the work might be carried on under his own supervision. After spending a few days with Professor Hall examining the structure of a part of the country between Albany and New York, he sailed for England on the 10th of August. From London he wrote on the 26th of the same month: "I remained in Liverpool all Saturday, my object being to ascertain whether my two casks and box had arrived. But I found all the world gone to a review of volunteers, Messrs. Allan Brothers, among others, having locked up their counting-house and left nobody to answer for them. I therefore had to remain until Monday. . . . I have seen Sir Charles

Lyell, who has asked me to lunch with him to-morrow, to talk of the Laurentian rocks and the discovery of Eozoon, which he calls a great event.

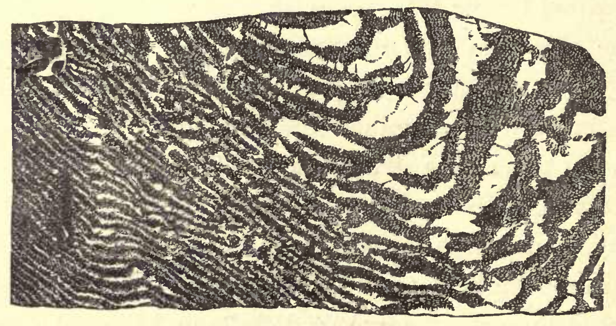
"On reaching the Great Western Hotel on Monday, I considered myself fortunate to find that Hart was here in the hotel, and that Margaret and Mr. Ker were in the Square. So we made up a good large party at seven o'clock, and I had my adventures to relate." Sir William had intended to get the printing of his maps done in Paris, but finding that the work could be equally well executed in London by Stanford of Charing Cross, he changed his plans and remained in England. Here he was for a short time but little occupied, and took advantage of the temporary leisure to visit some of his friends in Wales and Kent, and also to attend the meeting of the British Association at Bath. Speaking of his visit to Kent, he says: "On Monday I went down to Waterbury in Kent and stayed with Mr. and Mrs. B—— until Wednesday morning, so that you will see that I have lost no time in continuing my round of visits. Our niece M—— has a pretty and comfortable house, garden and grounds, and appears to be very happy. . . . On the morning of Tuesday I took a long walk, following the escarpment of the Chalk formation for several miles until I got to Maidstone, where I turned. My walk lasted from 10½ a.m. to 4½ p.m., and I must have done sixteen or seventeen miles. The valley of the Medway is very picturesque, and the country is covered with hops."

Accompanied by his brother Edmond, he reached Bath in time to be present at the meeting of the British Association, which opened there on the 14th of September.

His principal object in attending the meeting was to read papers on, and to show specimens of the recently christened Laurentian fossil *Eozoon Canadense*, concerning which a few facts may be given here. As early as May, 1858,* Dr. Hunt had argued from the chemical characters of the Laurentian rocks the probability of the existence of organic life at that early period, and in the autumn of the same year specimens from the Calumet Rapids were brought to Montreal by Mr. John McMullen, an explorer then attached to the Geological Survey, which recalled the appearance of the Silurian fossils known as *Stromatopora*. These forms were at once compared by Sir William with some similar laminated structures from the Laurentian of Burgess, Ontario, presented to the Survey by Dr. Wilson of Perth. The specimens were examined microscopically by Dr. Dawson, but no minute structures could be detected in them. As we have seen, however, Sir William ventured to bring them before the American Association at the meeting in Springfield in 1859, and argued their probable organic character from their definite and limited forms, and from the circumstance that the minerals filling the supposed cavities were different in different specimens, while the forms were the same. Sir William also carried specimens with him to London, and showed them to some of the geologists there, few of whom, however, seemed inclined to believe in their organic character. Notwithstanding this, one of the Calumet specimens was figured and introduced into the *Geology of Canada* in 1863, as a probable Laurentian fossil, though without

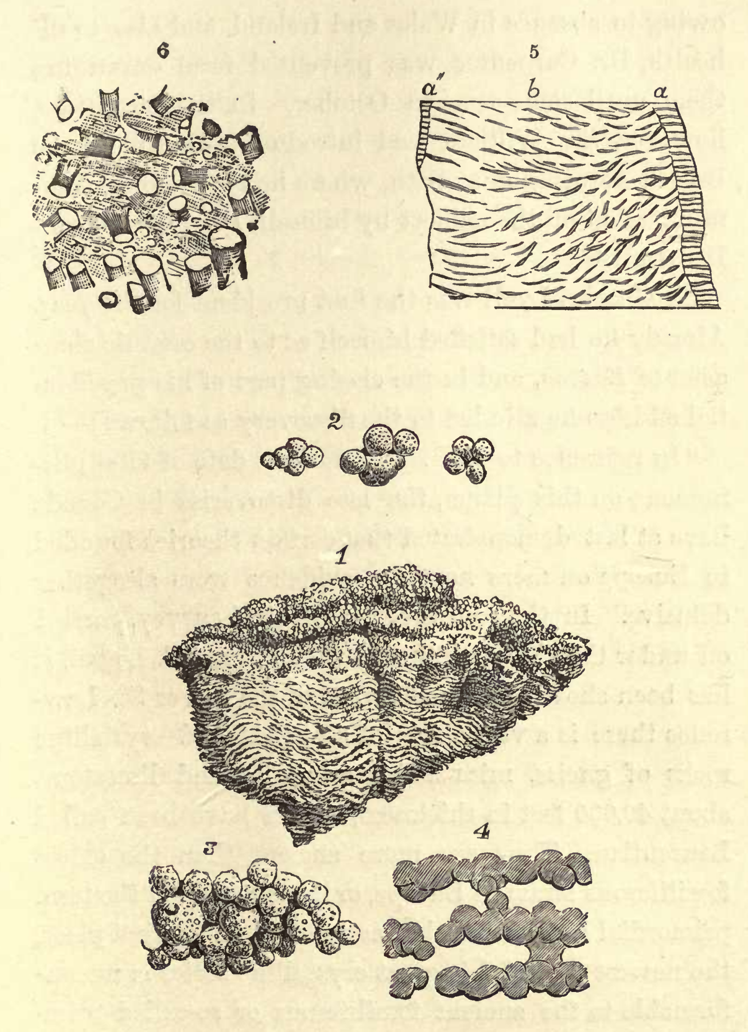
* American Journal of Science II., xxv., 426.

any name or technical description. Not long after this new specimens were obtained from a locality near Grenville on the Ottawa, by Mr. James Lowe, one of the Survey explorers, showing the characteristic structures which have since become familiar to microscopists. These new specimens were submitted to Dr. Dawson for microscopic study, and he at once recognized in them structures which he believed to be organic and to belong to an animal of the group of Foraminifera. The results of his examination he embodied in a detailed paper in which he proposed *Eozoon Canadense* as the name of the



EOZOON CANADENSE.
From a specimen collected by the late Dr. Wilson, of Perth, Ontario.
Dawson—" The Dawn of Life.'

new fossil. The Chemistry of *Eozoon* was discussed by Dr. Hunt in another paper, and the manuscript of these was taken to London by Sir William at the time of which we are now writing, in order that the whole matter might be submitted to Dr. W. B. Carpenter or some other recognized authority on the subject of Foraminifera. The specimens were submitted to Prof. T. Rupert Jones, but



EOZOON CANADENSE.

(1) Small specimen disengaged by weathering. (2) Acervuline cells of upper part—magnified. (3) Tuberculated surface of lamina—magnified. (4) Laminæ of Serpentine in section, representing casts of the sarcode—magnified. (5) Section magnified showing canal system at (*b*) and tubuli at (*a*). (6) Canals highly magnified.

Dawson—"Acadian Geology" and "The Dawn of Life."

owing to absence in Wales and Ireland, and also to ill health, Dr. Carpenter was prevented from examining them until some time in October. In the meantime, however, Sir William had introduced *Eozoon* to the British Association at Bath, where he read a joint communication on the subject by himself, Dr. Dawson and Dr. Hunt.*

Sir Charles Lyell was the first president for the year. Already he had satisfied himself as to the organic character of *Eozoon*, and in the closing part of his presidential address he alluded to the discovery as follows :—

"In reference to the . . . . earliest date of vital phenomena on this planet, the late discoveries in Canada have at last demonstrated that certain theories founded in Europe on mere negative evidence were altogether delusive. In the course of a geological survey, carried on under the able direction of Sir William E. Logan, it has been shown that northward of the River St. Lawrence there is a vast series of stratified and crystalline rocks of gneiss, mica-schist, quartzite, and limestone, about 40,000 feet in thickness, which have been called Laurentian. They are more ancient than the oldest fossiliferous strata of Europe, or those to which the term primordial had been rashly assigned. In the first place, the newest part of this great crystalline series is unconformable to the ancient fossiliferous or so-called primordial rocks which overlie it; so that it must have undergone disturbing movements before the latter or primordial set were formed. Then, again, the older half of the Laurentian series is unconformable to the

* "On Organic Remains in Laurentian Rocks in Canada."

newer portion of the same. It is in this lowest and most ancient system of crystalline strata that a limestone, about a thousand feet thick, has been observed, containing organic remains. These fossils have been examined by Dr. Dawson, of Montreal, and he has detected in them, by aid of the microscope, the distinct structure of a large species of Rhizopod. Fine specimens of this fossil, called *Eozoon Canadense*, have been brought to Bath by Sir William Logan, to be exhibited to the members of the Association. We have every reason to suppose that the rocks in which these animal remains are included are of as old a date as any of the formations named azoic in Europe, if not older, so that they preceded in date rocks once supposed to have been formed before any organic beings had been created."

Altogether *Eozoon* met with a most favourable reception from the Association, and during the discussion which took place after the reading of Logan's paper, Lyell went so far as to state that he looked upon this as the greatest geological discovery that had been made in his time. The importance of the discovery was fully recognized by Sir William. He saw that the structures could not well be accounted for by any theory of ordinary mineral deposit, and, as we shall see, he entered with a warm enthusiasm into the defence and illustration of the Laurentian fossil whose discovery changed the name of Azoic to Eozoic.

After the meeting of the Association, Logan went for a few days to Cromer in Norfolk, in order to join one of his sisters and her family who were staying there at the time. "I came down the day before yesterday," he

writes, "and we are just now collected to the number of twelve. To-morrow we shall be thirteen." From London he wrote to his brother James, on the 6th of October :—"On returning from Cromer last Monday, I found here your letters of the 12th and 16th Septr. . . . Mr. Bone, who colours the geological maps of the United Kingdom, is still endeavouring to make my colours match. . . . No doubt it would be a benefit if one system of geological colours could be adopted for all countries; but the distribution of the formations is so capricious that I fear that while the colours representing them might harmonize for one country, they might have a bad effect on the eye for another. . . . I have to-day ordered my grand specimen of *Eozoon* to be placed for show in the Museum of Economic Geology, on Jermyn Street, where I have no doubt it will be much examined and criticised." Two days later he again writes :—"I am to see Dr. Carpenter with the Laurentian specimens this evening. I am told, however, by one of his friends that he is by no means well, and that I must not fatigue him too much."

Dr. Carpenter having seen the specimens of Eozoon, at once expressed his belief in the correctness of Dr. Dawson's views, and a few days after wrote to Sir William as follows :—

"8 QUEEN'S ROAD WEST,
"*October* 14*th.*, 1864.

"DEAR SIR WILLIAM,—I have been giving as much attention as my present condition permits to the specimens you have placed in my hands; and I have found nothing to shake, but on the contrary everything to confirm, my first impression of the nature of your most

interesting fossil. I will write you more in full my ideas of its structures and affinities, which harmonise essentially with those of Dr. Dawson. But before doing so I am very desirous of seeing some characteristic specimens of *Receptaculites.* Some years ago when specimens of that fossil were first sent over to the Jermyn Street Museum, Salter showed me some; and my impression was that *if really fossils*, they were the internal casts of an organism nearly allied to *Orbitolites*, but on a gigantic scale. I have been looking again at a fragment which Salter gave me; and it seems to me that the two sets of specimens, so to speak, confirm one another; each independently affording a strong probability that at an early geological period the Rhizopod type attained a development which, in comparison with what we have since known, was colossal; and these two independent probabilities when combined amounting to an almost absolute certainty.

"If you have not any specimens of *Receptaculites* by you, I have no doubt that the authorities at Jermyn Street would lend you theirs for my inspection.—Believe me, yours faithfully,

"WILLIAM B. CARPENTER."

For some time *Eozoon* and geological maps continued to be the two subjects uppermost in Logan's mind, as will be seen by the following extracts from letters written, while in London, to his brother in Montreal:—

"*October* 21*st.*:—I have now got my map from Mr. Bone with the English colours on it. It looks very well. I have shown it in Jermyn Street, and they approve of

it. . . . I dined with Sir Edmund Head on Tuesday. Professor Tyndall was there, and I think there was a plot between them to get me to give a lecture at the Royal Institution on *Eozoon* and matters connected with it. The very thought of it would make me uncomfortable all the time I am here, and interrupt my work. I therefore civilly, but point-blank, declined.

"*October 29th.* :—I went afterwards [*i.e.*, after visiting a marble yard to see some Italian and other marbles] to the Survey Office in Jermyn Street, where they have given me the corner of one of their large tables to work at on my maps. Afterwards I went to the lapidary's to look after more slices of *Eozoon* for Dr. Carpenter, and the day went by before I knew it. When I got to the hotel the post hour had passed. *Eozoon* goes on swimmingly.

"*November 5th.* :—I am working without intermission at the maps. I have to use a magnifying glass to follow the limits engraved for the colours, and I assure you it is very fatiguing to the eyes.

"*November 8th* :—I am progressing here steadily but slowly. The days are so short that I cannot see to colour my map later than 4 o'clock; and as I work at a table which has been devoted to my use in Jermyn Street and cannot get into the museum before ten, I can with difficulty place more than two colours, sometimes three, on the maps in a day. . . . I have been invited by General Lefroy to dine with him at Blackheath. I go down by a train which leaves the Charing Cross Station at 6 p.m., and return the same evening. I am to meet Captain Noble who used to be in Montreal.

"*November* 12*th* :—I have still six colours to place, having now done twenty-three. With the present dark weather it is really distressing work. Sometimes in the middle of the day there comes from the city to the west end a yellow fog, rendering it impossible to see the lines. Were it not that I am near-sighted and can see the smallest objects without spectacles, I would not have been able to get on at all.

"*November* 17*th.* :—I have just finished the thirty sheets for the lithographer. It has been an awful job, on account of the dark weather.

"*November* 19*th.* :—I am to read the papers on *Eozoon* before the Geological Society on Wednesday next, the 23rd. inst., and I am preparing a map of the Laurentian districts about Grenville for the occasion. It is a copy of the one I had on a scale of three miles to an inch, augmented to one mile to an inch. All the lines, topographical and geological, have been put upon it, and I have worked until one o'clock for several nights. . . . In addition to the thirty partially coloured copies of the general map, I have now ready for Mr. Stanford the Phillipsburgh map. Stanford has engraved it beautifully.

"*November* 24*th.* :—Last evening our papers (my own, Dawson's, Hunt's, and Carpenter's) were read before the Geological Society, and I think we had a success.

"I have worked so hard to finish a map for the occasion that I am quite tired out. Ever since Friday last I have commenced by candle-light at six in the morning and continued until midnight. The night before last I kept at it until three in the morning. As the map was intended for candle-light effect, I put on a

large part of the colour at night. Some that I had laid on by daylight I altered at night, in consequence of finding that tints which had been very distinct from one another by day could not be distinguished by candle-light.

"*December 8th.*:—I think I told you that the Duke of Argyll was to notice our Laurentian fossil in his address to the Royal Society (Edinburgh) on Monday evening last. . . .

"One objector to the organic character of *Eozoon* was Mr. Woodward, a naturalist of the British Museum. But having shown him a specimen which I etched on Monday last, he relinquished his opposition, and said he was now convinced that *Eozoon* was an organic entity. Mr. Maskelyne, the Mineralogist of the British Museum, whose grand microscope was used for the purpose of examining the specimen, said that he did not know anything of organic forms, but that he would assert that *Eozoon* was not an inorganic one.

"There is now no one that I know who has seen the specimens and does not believe them to be fossils, so that I think *Eozoon* is pretty well established.

"*December 14th.*:—My sections have all been engraved on four sheets. I am correcting the proofs, and much correction they require—not in the lettering, which is well done, but in the lines showing the divisions of formations and the surface. . . . Dr. Carpenter is to explain the structure of *Eozoon* this evening before the Royal Society, showing under the microscope the specimens he has examined. Of course I mean to be there if I can; but I have engaged to be with Mr. Salter at 5 o'clock, this being his birthday.

"*December 17th.*:—Dr. Carpenter read his paper on *Eozoon* at the Royal Society on Thursday, and all went off beautifully.

"*December 22nd.*:—On the subject of *Eozoon* I have the honour to be in correspondence with the Duke of Argyll, who has written to me to enquire whether the specimen of Tyree marble in which Dr. Dawson got traces of the fossil was the salmon coloured with green spots (composed of sahlite), or the white with green spots of serpentine; for there are two kinds of Tyree marble. I have informed him that I thought it was the white with spots of green serpentine"

The first of January, 1865, came round, bringing to Sir William many a kindly wish for a Happy New Year. But kindly wishes could not avert impending sorrow, and before the year had elapsed two of the brothers whom he loved with all the intensity of his ardent nature had gone to their last resting-place. For some time Mr. Edmond Logan's health had been failing; but though his friends had experienced considerable anxiety on his account, they had not anticipated that his disease was so soon to terminate fatally. In January, however, the news which Sir William received seemed to be less and less favourable, and he determined to go to Edinburgh "to see for himself." There he soon learned from the lips of both Dr. Simpson and Dr. Duncan that recovery was impossible. Nor was the end long delayed, for on the 24th of the month the brother breathed his last.

Sir William was not a man who talked much of his sorrows, but rather one of those who in silence endure

the bitterness of pent-up grief. Deeply as he felt his loss, however, his active mind could not long brood over trouble, and though obliged to remain in Edinburgh for several weeks to attend to his brother's affairs, the proofs of his maps were regularly sent to him from London, and as regularly corrected and returned. The 22nd. of February found him again in London, where he remained most of the time until the end of May, when he left for Canada. Up to the time of his departure he continued to write regularly to his brother in Montreal, and from the letters of this period we give a few extracts.

"*March* 11*th.* :—Last night Ramsay gave a lecture at the Royal Institution on *Eozoon* and the Laurentian rocks of Canada, and various considerations connected with them in respect to geological time. It was very well done, and surpassed the lecture given to working-men. The audience was numerous, but not quite so overflowing as it sometimes is, the evening being a rainy one. The illustrations were excellent. Many of them there were those used at the former lecture, but some of them new. One of the new ones was a magnificent mass of *Eozoon*, in the form of a retangular block, supposed to be cut out of the rock, and to be uninjured by pressure or destructive agencies of any kind. The silicious skeleton was then supposed to have been dissolved away, so that what remained represented the sarcode or animal jelly in all its details, the scale being sufficiently large to indicate the larger and smaller branching tubuli, as well as the small nummulitic vertical tubuli lining all the chambers and cells. This was very effective.

"There were on one of the tables in the library of the Institution some pieces of the Connemara marble, in which it is said structure has been found; but I must confess they did not strike me as resembling *Eozoon.* There were no slices for the microscope, however, and of these I have not yet seen any. I am to dine with Dr. Carpenter to-day, for the purpose of inspecting a microscope which he has selected as one fit for good work and intended for the Survey. It is one of Smith and Beck's, and I suppose the cost will be about £20. I believe the Dr. has some thin slices of the Connemara marble, of structure in which he does not speak with much confidence, and I dare say I shall see some of them. I fear that examiners in examining serpentinous marbles with the microscope, will at first be very apt to refer all evidence of organic structure they may detect in them to *Eozoon*, whether the organisms be *Eozoon* or something else. . . .

"*March 23rd.* :— . . . In the American news among other things it is said that Mr. Seward has rescinded his passport system, and that the Americans do not intend to increase their naval power on the lakes. If this be true it will have an effect on Canadian securities and stocks.

"On Saturday Mr. Stanford supplied me with the first copy of the general map. I showed it to Sir Roderick Murchison, Mr. Ramsay, Mr. Reeks, Mr. Ethridge, Mr. Smyth, and others at the Museum in Jermyn Street. The general effect of the colours was very much admired by every one of them; Mr. Ethridge said it was the prettiest geological map he had ever seen. The

registering, however, is imperfect, and will require many trials to get it right. There are still the map of superficial geology and two sheets of sections to put on the stones. Mr. Stanford now promises them in ten days. . . ."

Sir William was greatly interested in the scheme for the confederation of the Provinces, believing that if carried into effect it would be for their mutual advantage. At the same time he felt that in all probability the Geological Survey would be placed under the control of the general government, and that the field of his operations would be greatly extended. His letters from London in 1865 contain frequent allusions to the subject.

"*March 25th.*:— . . . The confederation scheme appears to be going astray in Nova Scotia and New Brunswick, much to the regret of everybody on this side of the Atlantic. It is said that there will probably be another meeting of all the delegates at Montreal to see how matters can be adjusted. . . .

"*April 26th.*:— . . . Mr. Galt and Mr. Cartier have arrived and are staying at the Westminster Palace Hotel. I saw them this morning for an instant; but they were going to wait on Mr. Cardwell, by appointment, and had not time to say anything. I am to breakfast with them to-morrow morning at 9 o'clock.

"There is a report in the city to-day that Mr. President Lincoln has been assassinated; whether true or false, or how the report has come, I cannot say. If Johnson becomes President I think Canadian securities will experience a fall, as he seems red-hot for hanging

everyone and making war upon England. The loss of Lincoln would be a most serious affair for the world at the present moment.

"*April* 27*th.* :—It turns out that the death of Lincoln is too true. The Nova Scotian brought the intelligence. . . . I breakfasted with Galt and Cartier this morning and showed to Galt the progress made on the maps. The general map has still to be made to register perfectly. Stanford now says I shall have it by Saturday. . . .

"*May* 4*th.* :—I have received your letter of the 17th April, by which I regret to observe the decease of our friend Judge Gale. Will you have the kindness to express to the family the condolence of myself and our sister Agnes for their loss. Warning after warning comes that our own time will arrive at no very distant day.

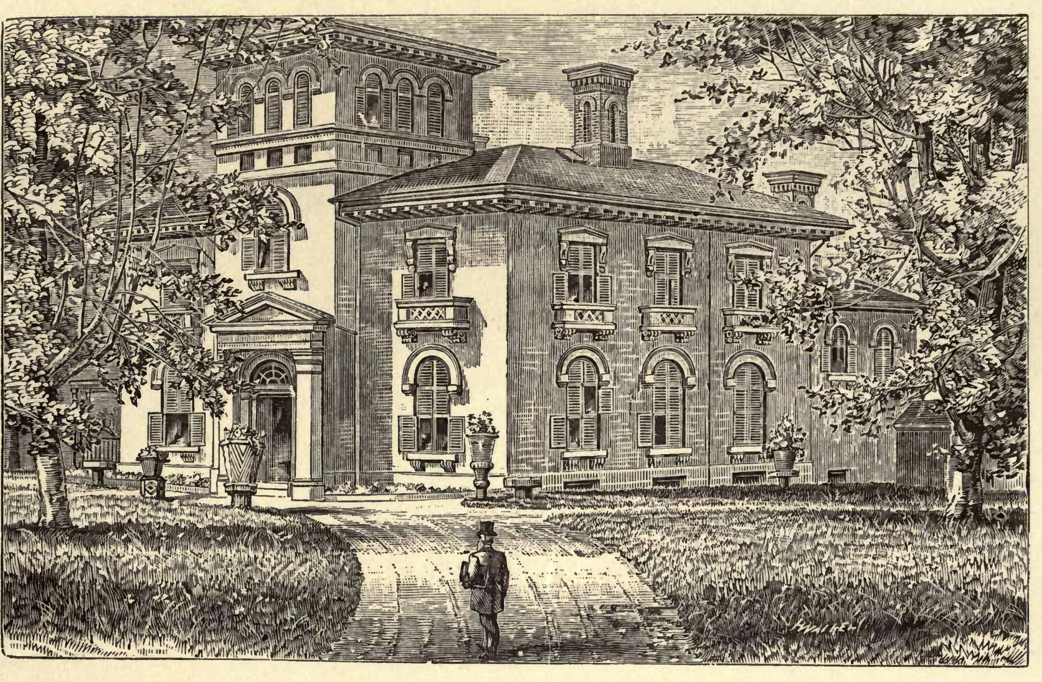
"I called on Brown and McDonald on Monday, and saw all the four delegates, but was not told anything of how they were getting on. Mr. McDonald said that the sympathy expressed by the Colonies for the death of Lincoln had much changed the feeling in New York in regard to them; and I am sure the sympathy here, which appears to be universal, ought to go far towards smoothing asperities of sentiment with regard to England.

"Dr. Carpenter has communicated a capital paper on the structure of *Eozoon* to the *Intellectual Observer*, of which he means to send copies to Hunt, Billings, and Dawson. It is illustrated by a first-rate coloured engraving showing a restoration of the animal, and by other figures of particular parts."

Sir William left for Canada on the 27th. of May, and on reaching Montreal found a source of deep anxiety in the illness of his eldest brother, Mr. James Logan. Instead of spending the remainder of the summer in the field as he had contemplated, he was obliged to be frequently in Montreal, and while there went out every evening to spend the night with his brother at "Rockfield" on "Logan's Farm." After the death of Mr. James Logan, which occurred on the 16th. of September, Rockfield became Sir William's solitary home whenever he was in Montreal.

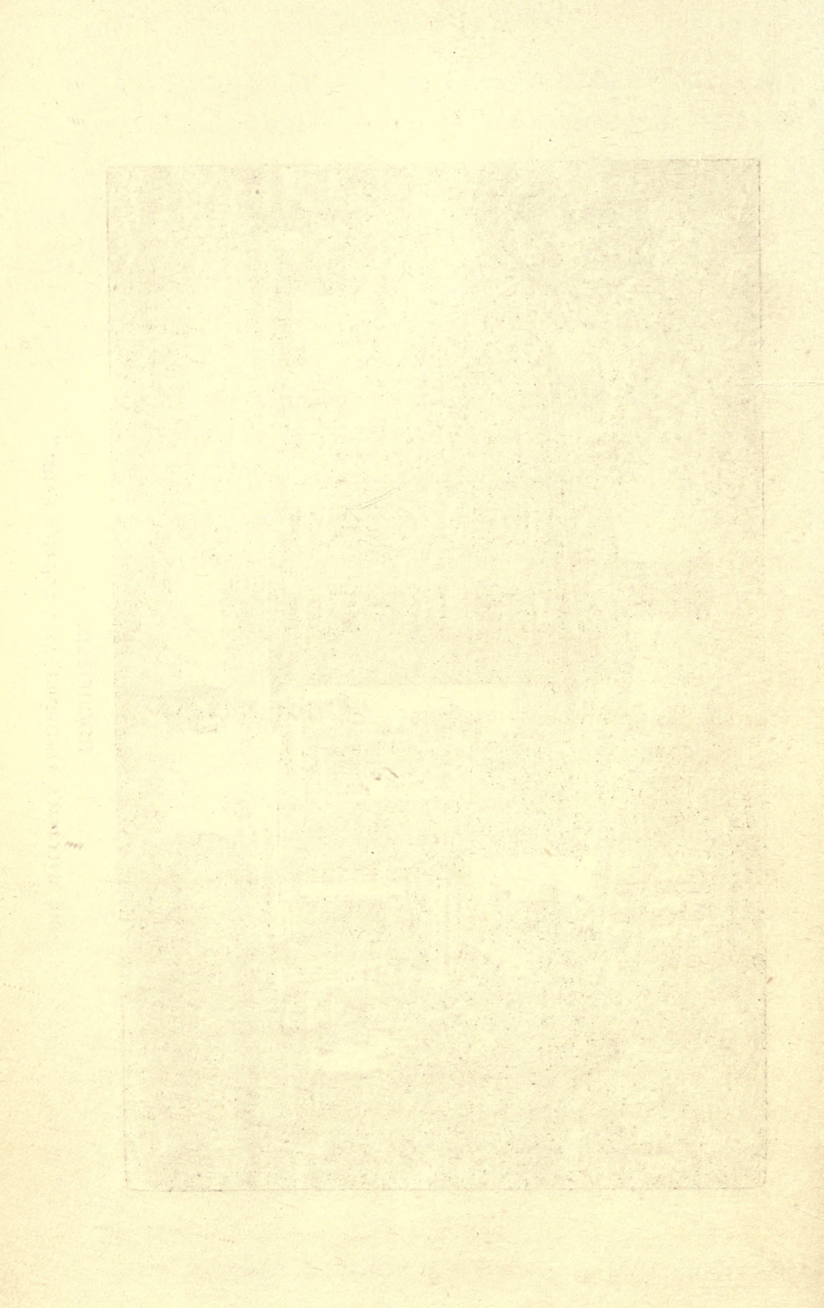
In 1866 Sir William devoted a good deal of attention to the geology of a portion of New England, which he thought would throw some light upon his investigations in Canada. Some time during the year, also, he received instructions to prepare a collection of the mineral products of Canada to be shown at the approaching Paris Exposition. Early in 1867 he went to London, and there worked so closely at the preparation of a geological map for exhibition at Paris, that he is said to have seriously injured his eyesight. Meantime, Mr. Richardson had accompanied the mineral collection to Paris, in order to attend to its arrangement there, and during the Exposition the Survey was represented by Dr. Hunt, whose thorough knowledge of the mineral resources of Canada, as well as of the French language, enabled him to do good service for the country. As at previous exhibitions, the Canadian geological collection was much admired and was awarded a number of medals.

Sir William himself did not wait to receive his



ROCKFIELD.

SIR WILLIAM'S RESIDENCE AT "LOGAN'S FARM."



honours, but returned to Canada early in June. In the following month his rank was raised by the Emperor of the French from Chevalier to Officer of the Legion of Honour, a just recognition of his long and valued services in the cause of science. In the autumn of the same year the Council of the Royal Society awarded him one of the two Royal Gold Medals of the year for his "geological researches in Canada, and the construction of a geological map of that colony." The friend who proposed his name says in a letter dated Nov. 8th., 1867:—"Some time ago I proposed you for one of the Royal Gold Medals given by the Royal Society. We voted yesterday in Council and you were carried triumphantly."

"I have just learnt," wrote Murchison on the same day, "that the Council of the Royal Society have awarded to you one of the two Royal Medals of the year, and I hasten to tell you how much pleasure it gives me, the more as it follows close on my dedication to you of the new edition of Siluria."

On the 8th of May, while in London, he read papers by himself and Dr. Dawson "On new specimens of Eozoon". The most important of these specimens had been discovered by Mr. H. G. Vennor, then one of the assistants on the Geological Survey, in the township of Tudor, about forty-five miles north of Lake Ontario. It was looked upon as particularly important from the fact of its occurrence in a limestone which had undergone comparatively little alteration, and which was therefore less likely to contain dendritic concretionary mineral forms simulating organic structures.

CHAPTER XVII.

CLOSING YEARS.

ALTHOUGH Sir William's great geological map bears date 1866, it was really not published until 1869, and in March, 1868, he was obliged to go to London to attend to the work as it was in progress. Early in June, however, he was back in Canada, and shortly afterwards we find him busily engaged with preparations for geological field-work. Accompanied by the late Mr. W. B. Hartley, whom he had engaged as his assistant, he left for Nova Scotia about the end of of July, and began an investigation of the structure of the Pictou coal-field, which long before he had visited when making his researches concerning Stigmaria. For many years his geological work had been almost entirely confined to regions occupied by contorted and folded metamorphic strata, and it must have been pleasant for him once more to return to the Carboniferous formation, from which he had derived his first geological inspirations. And yet the Pictou coal-field offered no easy problem in geology, but rather a sort of gigantic

Chinese puzzle composed of numerous pieces due to a complicated series of faults. This is made evident from an inspection of the map of the Pictou coal-field accompanying the reports of Sir William and Mr. Hartley. The map shows that the productive Coal measures are on every hand bounded by rocks of the Millstone Grit and Devonian formations, brought to the surface by faults and limiting the area of the productive measures to about twenty-two square miles.

In his report on the district examined, Sir William groups the rocks as follows, in ascending section:

1. Conglomerates, quartzites and compact slates.
2. Greenish-grey and red sandstones, with conglomerates and impure limestones.
3. Red coarse conglomerates.
4. Productive coal measures.

(Nos. 2–4: Carboniferous.)

The rocks of No. 1 are, on the authority of Dr. Dawson, stated to be Devonian. No. 2, again, are supposed to represent the portion of the Joggins Section in the Bay of Fundy referred by Dawson to the Millstone Grit formation. Though somewhat different in aspect, Sir William regarded the rocks of this division as the equivalents of the series in Gaspé, which he had many years before called the Bonaventure formation. The red coarse conglomerates of No. 3 are those which Dr. Dawson had previously described as the New Glasgow conglomerates. They have evidently been derived from the Millstone Grit formation, to which, according to the evidence of Mr. Hartley, they are unconformable. Group No. 4 includes the celebrated "main seam," thirty-five feet thick, and beneath it one of twenty-

four feet, one of five and one of eleven, all in a thickness of 500 feet.*

Altogether, Logan spent only three months in Pictou, and entrusted the further carrying out of the work to his assistant, Mr. Hartley, in whose abilities he seems to have had the greatest confidence. Mr. Hartley accordingly returned to Pictou in 1869 and again in 1870, but in the autumn of the latter year, through over-exertion and exposure, brought on the illness which so soon terminated his life.

In a previous chapter we have already seen how in earlier years Logan looked forward to the time when he should not only investigate the geology of Upper and Lower Canada, but should extend his researches from ocean to ocean, from Atlantic to Pacific. But the years had swiftly passed, and now that Confederation had widely extended the field of his operations, he began to realize that he was fast becoming an old man and had not the strength to cope with the enhanced responsibilities. His estates, too, had greatly increased in value, and daily required more and more of his personal attention. Under these circumstances he resolved to resign the position which he had held for more than a quarter of a century, feeling that if relieved of the duties devolving upon him as Director of the Survey, he might with greater advantage devote himself to his favourite science, and would also be free to spend such time as he saw fit with his friends in Britain. His resignation was tendered to the Government in the

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* This is on the west side of the East River.

month of January (1869), and on his recommendation Mr. A. R. C. Selwyn, who for many years had directed the Geological Survey of Australia, was in December appointed as his successor. It was with feelings of deep regret that the public received the announcement of Sir William's retirement, and never was the press of any country more unanimous in its expressions of approval at the career of a public servant. Not long after his retirement, he wrote to an old and distinguished conchological friend in England:—

"ROCKFIELD, MONTREAL,
"18*th. Feb.*, 1870.

"MY DEAR JEFFREYS,— . . . . It is quite true that I have resigned the directorship of the Geological Survey of our Canadian Dominion. It had become too great an exertion for a man of my age to attend to so widespread an investigation. I am not, however, quite free yet, as I have to transmit to the Government printed reports of explorations which were made under my authority in various parts of the country, and for the results of which I am responsible. It has been my hope to visit the other side of the Atlantic before the spring; but it is not quite a certainty that I shall get through my task of attending to the press in time.

"It will be my wish to show myself on your side of the Atlantic more frequently than I used to do; but my permanent residence is here, where I shall be happy to dig up some of the soil to show you Arctic shells when you come out. For even if I should be at some distance when you present yourself in these parts, I shall make a point of coming to meet you. One of my fields is

pretty well stored with these said shells, but the species are only the common ones. I saw a good many of them, just before our winter's snow fell, in two or three pits which had been sunk for agricultural purposes. If you should feel inclined to delve in this field of mine, bed, board, men and tools will be placed at your disposal, and I shall deem it strange that we who used to dig together in the bone caverns of Gowerland should be shell-grubbing together on my paternal acres in Canada."

Before his retirement from the Survey, Sir William endeavoured to establish a School of Mines in connection with the Museum at Montreal, modelled after the Jermyn Street School in London; but unfortunately the scheme fell to the ground. About the end of March (1870) he sailed for Britain, in order to visit his friends there and also to attend to various matters of business. Harassed as he had for some time been by the multitude of affairs to be settled in connection with his retirement from public life, he greatly needed rest and change, and the quiet of such a place as his sister's home in Wales must have been particularly grateful to him. In June he was back in America, and not long after we find him in Massachusetts, striving to throw light upon the geology of eastern Canada by a study of the Green Mountain series as developed in that state.

Dreading the long Canadian winter, and no longer tied down by official responsibilities, he again crossed the Atlantic in January, 1871, and remained with his friends on the other side until May, when he returned to Canada. Before going to Montreal, however, he went

to St. John's, Newfoundland, to visit his friend Mr. Alex. Murray, the sharer of his toils in the early days of the Canadian Survey. Sir William spent several weeks in Newfoundland, studying a little of the geology of the island and examining the interesting collections accumulated by Mr. Murray. On his return to Montreal he resumed the temporary directorship of the Survey during the absence of Mr. Selwyn in British Columbia. This, however, did not preclude him from returning to the Eastern Townships, and devoting several months there more particularly to a study of the rocks in the neighbourhood of Melbourne. A new interest now attached to the rocks of this region; for the correctness of the views which he had for years promulgated with regard to them had recently been called in question by Dr. Hunt, whose earlier opinions concerning metamorphism had gone far in confirming Sir William in his interpretations based upon stratigraphical evidence. "My present investigations," wrote Sir William to a friend, "have been undertaken with much inconvenience to myself, in consequence of some of my work having been (needlessly, as I am persuaded) called in question." It was indeed a sore trial for him thus late in life to retrace the footsteps of past years; but feeling that his reputation as a geologist was at stake, he took to the field at a time when his health demanded that he should take rest, determined to settle the question by observations on the ground. As is well known, he continued his work in the Townships for several years, but had not completed his investigations or published any of his conclusions when called away by death.

After his return from the field in September, he was delighted by a long-promised visit from his friend Mr. J. Gwyn Jeffreys;* while in the following month he was greatly grieved by news of the death of Sir Roderick Murchison, who, like Sir Henry de la Beche, had always been his warm friend and supporter. The winter of 1871-72 was spent in Canada, and with the return of spring he again went to the Townships for another season's work. Most of the following winter was spent with his friends in England, but by April he was back in Canada,† and was soon hammering away as hard as ever at the rocks of the Townships, Danville being his head-quarters for most of the summer. In the autumn he

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* Mr. Jeffreys refers to this visit in the following reminiscences, kindly contributed for this volume: "My earliest recollection of the late Sir W. E. Logan dates from 1836, about which time he came to Swansea and joined Mr. Starling Benson in taking some heaps of 'slag' or metallurgic refuse for the purpose of extracting copper. They also leased and worked a colliery at Penclawdd, six miles from Swansea. The latter undertaking led to Mr. Logan's investigation of the South Wales mineral basin, which attracted the attention of Sir Henry De la Beche. Mr. Logan and I were for some years the co-secretaries of the Royal Institution of South Wales; and he was the geological, I the zoological curator of the Museum. After he left Swansea I saw very little of my friend until I also left and went to live in London. In 1871 I visited North America, and was his guest at Logan's Farm, Montreal. We examined together the fossiliferous and so-called glacial beds in that district. My long acquaintance with him, although intermittent, left the impression on my mind that he was not only very talented, but remarkably amiable. He was full of humour, and the way in which he sang 'The Laird of Cockpen' will not easily be forgotten by those who heard him. His manner was delightful, and he was a thorough gentleman."

† It was shortly after his return from England on this occasion that the following incident occurred. We give it as related to us by a gentleman in Montreal: "On his return from England in 1871, Sir William called at the office of a friend to obtain an address. The friend not being within, the clerk to whom he addressed himself, and to whom Sir William was

received news of the death of his only surviving brother, Mr. Hart Logan, and was much affected by the unexpected loss. Though his health was far from good, he determined to spend the winter of 1873-74 in Canada, and although he stirred little from his solitary home at Rockfield, he occasionally visited the offices of the Survey, where every one was pleased to see him; for his face still wore its merry smile, and he still exhibited a keen interest in every question connected with the geology of the country. When at Rockfield his evenings were often spent in reading novels, of which he was always very fond and over which he many and many a time shed tears like a school-girl. During the

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personally unknown, rendered the desired service. The slouched hat, much the worse in colour for exposure to sun and shower; the ill-fitting suit, innocent of acquaintance with a clothes-brush; the muddy knee-boots, the long hair, shaggy beard and spectacles, altogether, gave him the appearance of a gardener out of employment; and his apparent ignorance of some of the chief streets of the city, led the clerk to the conclusion that he was a stranger from the country—so he good-naturedly offered to pilot him to his destination. On the way the little old gentleman exhibited considerable power of walking, which, however, did not interfere with a lively conversation. On being asked where he had been living lately, he replied that he had just returned from Wales. 'I have friends in Wales,' said his guide; 'they live at C——.' 'Ah! that is on the lime,' replied the active little stranger. 'My sister lives at L——, which is on the slate.' Other places he had visited were described as being on the coal, on the lime, and so forth. Such a strange description of locality the guide had never heard before, and he wondered who his odd-looking but interesting companion could be. Nor was his astonishment less when he noticed that many of the gentlemen they met on the way saluted him with evident respect. It was clear, too, the little gentleman observed his guide's mystification, and thoroughly enjoyed it. Having seen him safely to his destination, and having derived much pleasure from the conversation, the clerk on his return, seeing one of the gentlemen who had recognized his companion in the street, enquired who he was, and was informed that it was Sir William Logan."

summer of 1874 he spent several weeks in the Townships where he did his last geological work; and in August, accompanied by his secretary, Mr. G. R. Grant, he once more sailed for the mother country. This was his last voyage, although at the time he looked forward to returning to Canada in the spring. During the winter, while he was staying with his sister in Wales, the disease which for some time had been insidiously creeping upon him became rapidly aggravated. "I grieve to say," wrote his sister on the 22nd. of January, "that we are in a state of great anxiety about Sir William. His disease has made great strides, but the doctors do not despair of doing him good if we can but keep up his strength; but he is very weak. . . . We sit up with Sir William every night now." On the third of February his condition was somewhat improved, but he evidently felt that he should never be well enough to return to Canada. Writing at the time to a friend in Montreal, his sister says: "He wishes me to tell you that he is now disposed to take up his abode altogether in this country, and I need hardly say what a satisfaction the determination will be to all his friends on this side the Atlantic." In another letter written on the 10th. of the month she again says: "I am very much grieved to say that I see no improvement in my dear brother since I wrote last. In spite of all the nourishment he takes he seems weaker. . . . He wrote a short note to Mr. Whitaker yesterday, and was dreadfully tired after it."

On the 16th. of February, as no change for the better had taken place, Dr. Hulke of London was telegraphed

for; but on his arrival the following morning he found little to change in the treatment of the local physician. Most of the time confined to bed and unable to read or write, Logan's mind perpetually reverted to the work which he had left behind in Canada. For some time negociations had been pending between him and certain persons in London with regard to boring operations with a diamond drill which he wished to have carried out in the Eastern Townships, and which he thought would enable him to demonstrate the correctness of his views. He was particularly anxious that the boring should be begun in the spring, and was much annoyed by the tardiness with which the negociations proceeded. A Mr. —— had promised to go to Wales to discuss the matter with him; but as day after day passed and he did not make his appearance, Sir William grew very impatient and began to think that he was "fighting shy of him." The site for the bore-hole in Canada he had already indicated, and although he had evidently given up all hope of being able to return to Canada himself, he felt that his presence there was really not essential, inasmuch as the cores from the hole could be forwarded to him in England for his inspection there.

On the 15th of March he was able to write a long letter to a friend in Canada, from which a few extracts may be given:—

"I dare say you will be glad to see my hand again. I have hitherto been interdicted from writing, and the present act will show you that there has really been some improvement in my health. I need never hope,

however, to be in perfect health again. . . . My friends, both here and in London, were anxious that some man of confirmed reputation should be called in to give his opinion upon Dr. N——'s treatment. The gentleman decided upon was Mr Hulke He is third in rank, but first in authority, in the Middlesex Hospital, and enjoys a reputation He is one of the surgeons who were called in at the last illness of the Duke of Wellington. He is a man to whom you take at once—gentle and considerate in his manner, and extremely attentive to every word that is said. . . . After mature consideration [he] said that it was very gratifying to find that Mr. N—— had done everything so nicely, and that I was fortunate in having met with such a man, whom he knew to be a warm-hearted fellow, one desirous of sparing every possible pain, yet always acting up to what he considered necessary. He (Dr. N.) has along treated me with the utmost tenderness, more as if I had been his father than his patient.

"Mr. Hulke's visit cost £190. Last week I asked Mr. N—— for his account for medical attendance up to the first of March, as I was desirous of paying it periodically instead of waiting to the end of the complaint, as one did not know how long it might last. He has attended me from the middle of December, visiting me twice nearly every day, and often remaining all night. . . . Dr. N—— is in partnership with his father, though from age the father can now do nothing. In paying the account the £57 13s. 6d. was in a cheque to the firm; but I made the son a present of £100 for himself. He said it was the first large fee he had ever received, and

was very thankful for it. The family is not very well off. . . ."

In a postscript to the letter, written two days later, he adds :—

"The moment I fell ill, Dr. N—— recommended me to get a professed surgical nurse, and we were fortunate in procuring one from the establishment of Mrs. W——, an institution from which nurses of experience are supplied at one guinea per week. . . . The money is paid to Mrs. W—— at the expiration of every month, and not to the nurse, who of course is remunerated by Mrs. W—— according to agreement between them. We are particularly requested to give no money to the nurse, but we may give her a writing expressing our opinion of her and stating what good qualities we consider her to possess. I am ready to give mine—Mrs. Fletcher she is called—a high character for care, cleanliness, experience, and fifty other good qualities. . . . She is gentle, strong, and never seems to be at a loss what to do in an emergency. . . ."

By the middle of May, Sir William's health was so far improved that he was able to go to Tenby and spend a fortnight there. Not long before he had purchased a carriage and pair of horses of which he was very proud, and while at Tenby he went nearly every day for a drive with some of his friends. The weather was fine and at first his appetite improved daily; but the improvement was only temporary. While at Tenby, still intent upon the prospective boring operations, he wrote :—

"TENBY, 26*th. May*, 1875.

"MY DEAR MR. G.,—I have to acknowledge your letters of the 30th. April and 7th. May. The former ought to have been acknowledged by the last post; but I took a drive to Carew Castle without recollecting that it was mail day. Mr. L—— at length contrived to see me here yesterday, and made his proposition for the bore-hole in the Eastern Townships. It is to be 950 feet and is to cost somewhere near the $8,000. He is to write me a letter from London to-morrow after seeing his brother, with a statement of the conditions, and I am to accept them by a return letter. One thing to be considered in the selection of a position is water, a good deal of which is required. Not far from the spot which I had indicated there is a marsh which is discharged by a brook, and perhaps it will not make much difference if the vicinity of the brook is selected. The hole would go through the same strata with a small addition of chloritic slate at the top. . . . It will be the middle of June before Mr. L—— will be able to commence the bore-hole. . . . I do not think I have made any great progress in health at Tenby. We mean to return to Castle Malgwyn on Tuesday the 1st. June."

On the 4th. of June he wrote, though with an unsteady hand: "The weather is nice and warm, and I am a little stronger. Capt. Stewart has lent me a Bath chair, and I was out up the dingle in it before seven o'clock. The dingle and the garden and all the country are looking beautiful and there is great promise of all kinds of fruit." On the 12th. of June he was again in the garden peacefully drinking in the beauties of that

wondrous Nature which had so long been his delight and inspiration. The balmy air, the flowers, the birds, the very pebbles at his feet, all seemed to gladden his heart and even to give him fresh bodily vigour. But, alas! it was only the glow preceding nightfall. The garden was visited no more, and indeed from that time he scarcely left his bed. Day by day he grew weaker, and the weary watchers at his bedside saw that life was fast ebbing away. As the end approached he suffered much from pain and exhaustion, and when death came on the 22nd. of June, "it was almost a relief to his friends to see him at rest."

And now he sleeps in the quiet churchyard of Llechryd between his brother Hart, and his "great friend" and brother-in-law, Mr. A. L. Gower. Peace to his memory! Honour to his name!

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Those who had the good fortune to know Sir William Logan will remember him not merely as an enthusiastic geologist, but as a frank, true and genial friend. Many a fellow-creature was cheered by his cheerfulness, helped by his kindly advice and sympathy, or in the more substantial way which ample private means rendered possible. In many respects his was a solitary life. Unlike his great contemporaries, Murchison and Lyell, he never enjoyed the sympathy and assistance of a wife. His over-active mind, no doubt, needed to be drawn from the geological grooves in which it ran, and if on returning to Rockfield, after the worries of the office or the hardships of the

forest, there had been more of the attractions of home, his life would have been happier and possibly even longer than it was. As he grew old, he must have often experienced a sense of his loneliness, and we have already seen that during his declining years he more and more turned for sympathy to the sisters who had been the fond companions of his boyhood.

Though Sir William was possessed of a vigorous constitution and great powers of endurance, enthusiasm and interest in his work often carried him beyond his strength, and caused him to undergo excessive hardship and fatigue. As is so frequently the case with men of note, his tastes were very simple. His dress was the plainest, and he cared little for the luxuries of the table. Though brought up in accordance with the principles of Presbyterianism, he was rarely to be found in the kirk, and seven days a week seemed all too short for the absorbing pursuit of science. At heart he was a true tory, but owing to his position as a Government servant, he carefully avoided meddling in any way with political matters. The skill with which he steered his bark among the shoals caused by party legislation, in the end winning for himself and his work the praise and confidence of all, shows that he was possessed of remarkable sagacity. There was never any surrender of his personal independence, but by tact and a quiet, good-natured, irresistible persistence his objects were attained; so that years before his death he had the satisfaction of seeing the Survey established upon a comparatively liberal basis, and of feeling that, largely through his own exertions, the usefulness of

geology and a geological survey were far better appreciated in Canada than when he began his work there. When we bear in mind how late in life he entered upon his career as a man of science, how many difficulties he had to contend with in a new country like Canada, and how much of his time was taken up with European exhibitions and official drudgery, we are surprised at the quantity of geological work which he accomplished. It is true, however, that if he laboured under some disadvantages, there were also circumstances greatly in his favour. When he began the Canadian Survey he was already personally known to the principal geologists of Britain, who naturally took a deeper interest in the work than if it had been undertaken by one who was a stranger to them. He came also to an almost entirely unexplored field, which had all the charms of novelty and was ready to yield up discovery on every hand.

Like many of the geologists of his day, Logan had only a limited knowledge of chemistry, mineralogy and palæontology; but he had the good sense to recognize his deficiencies and to supplement them by securing the services of men who were towers of strength in the departments which they represented. His own special field was that of stratigraphical geology, and among the ups and downs of anticlinal and synclinal he was most thoroughly at home. Indeed, for such combined topographical and geological work as he had to carry on he was eminently qualified. As a close observer and careful delineator of facts he excelled, but his mind was not of the

speculative type, and he rarely indulged in the flights of fancy so common among geologists.

Earnestness and singleness of purpose were among the most marked features of Sir William's character. From the time that he began the Geological Survey until the day of his death, the great aim which was perpetually before him was to thoroughly elucidate the geology of Canada, and to render the knowledge acquired subservient to the practical purposes of life and to the advancement of his native country. He was continually beset with requests to examine and report upon mines in various parts of the country, but invariably refused, unless he felt that the information derived would be of advantage to the public. Nor would he on any such occasion accept of remuneration for his services. Any *bona fide* attempt on the part of individuals or companies to develop the mineral resources of the country was sure of his encouragement and advice if asked for; but the impostors who tried to palm off "salted" mines or impossible geological discoveries upon the unsuspecting public, he despised, and always took an intense pleasure in exposing their schemes. "During the time of a gold excitement in the Province of Quebec," writes Professor H. Y. Hind, "he was not unfrequently urged to give his opinion on gold-bearing quartz. On one occasion a number of specimens were shown to him by some speculators, in the presence of intending purchasers of the property. Sir William's opinion was asked whether the glittering metal visible at the bottom of the little cavities in the quartz was really

gold. 'No doubt of it,' said the unmoved critic, after eyeing it closely with a pocket magnifier. 'No doubt of it; and with this glass you can see the marks of the punch perfectly.' On another occasion, when pestered to give an opinion on a copper-bearing area, after reiterating without avail that he was a geologist but not a mining engineer, he was pressed for an answer to the question whether there was not an enormous quantity of copper within the area described; he satisfied both the intending seller and contemplating purchaser by the reply, 'There is an enormous quantity of copper—an enormous quantity; and it is my opinion that it will cost just a little more than it's worth to get it out.'"

Sir William had little capacity for literary work, and although he usually expressed himself with precision and force, his style was lacking in ease and gracefulness. Fine writing, however, was not his object, but rather to describe in simple language the results of observations in the field. In addition to his valuable reports to Government, which together would make several bulky volumes, he published a number of interesting papers, some of which have been noticed in the foregoing pages.* As he advanced in life, he found the work of composition more and more arduous. For some years before his death he contributed nothing to the literature of science, and even ordinary correspondence became increasingly distasteful to him.

Sir William's more important work in the cause of

* For a list of Sir William's more important reports and papers, see Appendix B.

science may be briefly summed up as follows:—(1.) Investigations with regard to the origin of coal, which resulted in a much clearer understanding of the subject than had been current before his time. (2.) The establishment of the Laurentian system as a great series of stratified crystalline rocks, divided into several groups, and containing at certain horizons evidences of organic life. (3.) The proof of the existence of a second series of crystalline stratified rocks (the Huronian) resting unconformably upon the Laurentian. (4.) The identification of the various formations of Canada younger than the Huronian, and the establishment of the fact that the inferior rocks of the Palæozoic series rest unconformably upon the Laurentian and Huronian. (5.) The production of a number of admirable geological maps, giving not only the results of his own explorations and those of his staff in Canada, but including the work accomplished by various geologists in the other British Provinces and in parts of the United States. In the execution of these maps he was very greatly indebted to the skill of Mr. Robert Barlow, late Topographer of the Survey.

Sufficient has already been said to show that the interests of Canadian science must have been greatly promoted by Sir William's exertions at the great exhibitions of London and Paris—exertions whose value has never been fully realized.

Logan was not only a Fellow of the Royal Society of London (1851), the Royal Society of Edinburgh (1861), and the Geological Societies of London (1837) and Edinburgh (1867), but also a Member of the

Geological Societies of France (1842) and Belgium (1874), of the Imperial Leopoldo-Carolinian Academy of Germany (1857), the Philadelphia Academy of Natural Sciences (1846), the Maine Historical Society (1847), the Academy of Sciences of St. Louis (1857), the American Academy of Arts and Sciences, Boston (1859), the State Historical Societies of Wisconsin and Iowa (1859), the American Philosophical Society (1860), the Buffalo Society of Natural Sciences (1863), &c., &c. He received the honorary degree of Doctor of Civil Law from the University of Lennoxville in 1855, and that of Doctor of Laws from McGill University in 1856. He was also the recipient of more than twenty medals, awarded to him on various occasions as a recognition of his scientific work.

APPENDIX A.

THE QUEBEC GROUP.

BY PRINCIPAL DAWSON, C.M.G., F.R.S.

When Sir William Logan commenced the Geological Survey of Canada in 1842, these rocks, in so far as his field was concerned, were almost a terra incognita, and very scanty means existed for unravelling their complexities. The "Silurian System" of Murchison had been completed in 1838, and in the same year Sedgwick had published his classification of the Cambrian rocks. The earlier final reports of the New York Survey were being issued about the time when Logan commenced his work. The great works of Hall on the Palæontology of New York had not appeared, and scarcely anything was known as to the comparative palæontology and geology of Europe and America. Those who can look back on the crude and chaotic condition of our knowledge at that time, can alone appreciate the magnitude and difficulty of the task that lay before Sir William Logan. To make the matter worse, the most discordant views as to the relative ages of some of the formations in New York and New England which are continuous with those of Eastern Canada, had been maintained by the officers of the New York Survey.

Sir William made early acquaintance with some of these difficult formations. His first summer was spent on the coast of Gaspé and the Baie des Chaleurs, where he saw four great formations, the Quebec group, the Upper Silurian, the Devonian, and the Lower Carboniferous, succeeding each other, obviously in ascending order, and each characterized by some fossils, most of which, however, were at that time of very uncertain age. More especially was this the case with the Lower and Upper Silurian series, which differed considerably in mineral character from their chronological representatives in New York and Western Canada; while the fossils contained in them were often peculiar, and could only be roughly corre-

lated with the few forms at that time published by the New York Survey. Still this work of 1842 and '43 was plain and easy compared with that which arose in the tracing of these formations to the south-west. Sir William's work on these rocks was characterized by extraordinary care and exactitude, the stratigraphy and every feature of the rocks having been elaborately observed and noted down. Much of the detail in these early note-books of Sir William still remains unpublished. Those who would detract from the work of Sir William Logan, if there are any such, should remember these early beginnings, and compare them with the massive foundations which have been laid for us to build upon.

This early work in Gaspé and its vicinity was only the commencement of the labours of thirty years extended over all parts of Canada, and re-inforced by several able assistants, and more especially by Messrs. Murray and Richardson. These labours are elsewhere referred to, and we may here sum up the general results with reference to the older formations, more or less connected with the Quebec group. (1) All the comparatively flat and undisturbed formations of the great plains of Upper and Lower Canada, the Canadian portion of the interior continental plateau of America, have been worked out and mapped, and their fossils characterized so that a child may read them. (2) The complex hilly districts with their contorted, disturbed and altered beds, which extend from New England to Gaspé, have been traversed in every direction, the limits of their different formations marked, and a theory as to their age and structure put forth, which, whether we accept it or not, has in it important features of the truth, and rests on facts on which every disputant must take his stand. (3) The still older formations of the Laurentide hills have been traced in their sinuous windings, and arranged in an order of succession which must stand whether the names given by Sir William, and now accepted throughout the world, be objected to or not. After the work of Sir William Logan, no cavilling as to names can ever deprive Canada of the glory of being the home of the scientific exploration of the Laurentian; and much examination of the ground which he explored enables me to affirm that no one will ever be able permanently to overset the general leading sub-divisions which he established in the Laurentian and Huronian systems.

Before defining more particularly the work of Sir William in the Quebec group, it may be well to notice some general geological facts which must be present to our minds if we would enter intelligently into these discussions. The formations with which we have to deal in the more ancient geological periods all belong to the bed of the sea. Now in the sea bottom there have been in process of deposition, side by side and contemporaneously, four different kinds of material, differing extremely in their mineral character and in the changes of which they are susceptible. The first of these consists of earthy and fragmental matter washed by water from the surface or sea margins of the land and deposited in belts along coast-lines, or on broader areas where ocean currents have been drifting the detritus

ground from the land by ice or washed down by great rivers. The second consists of organic remains of shells, corals and foraminifera, accumulated in coral reefs and the debris washed from them, in shell beds and in the chalky ooze of the deep ocean. Some beds of this kind are very widely distributed. The third is composed of material ejected by igneous action from the interior of the earth, and either spread in the manner of lava-flows or of beds of fragments and fine volcanic ash. Such rocks naturally occur in the vicinity of volcanic orifices, which are often disposed in long lines along coasts or crossing ocean basins, but fragmental volcanic matter is often very widely distributed by ocean currents and is interstratified with other kinds of aqueous deposit. The fourth and last description of bedded matter is that which is deposited in a crystalline form from solution in water. In later geological times at least, such deposits take place in exceptional circumstances, not of frequent occurrence. Such beds are dolomite, greensand, gypsum, and rock salt.

Now it may be affirmed that at each and every period of the earth's geological history, all or most kinds of these deposit were in progress locally. But it may also be affirmed that in certain geological periods there was a predominance of one or more over very great areas; and that in any particular area, even of considerable size, there may be definite alternations of these different kinds of material characteristic of particular periods.

Again, along certain lines of the earth's crust, the beds deposited by water have been folded and crushed together, probably by the contraction of the earth's shell in cooling, and along these lines they have been changed, in the way of hardening and becoming crystalline or in being chemically recompounded—alterations which are usually known as metamorphic. But still further, some kinds of deposit are much more liable to such metamorphic changes than others. More especially the beds of igneous origin, from their containing abundance of basic matter, as well as of silica, very readily change under the influence either of heat or water, becoming it may be highly crystalline, or having new mineral substances formed in them by new combinations, or, on the other hand, when acted on by water combining with it and forming hydrous silicates.

One other curious coincidence it is necessary to mention.—It is where the greatest deposits of sediments are going on along coasts or in the course of currents, that crumpling and bending of the crust are most likely to occur, and igneous ejections to be thrown out; and conversely, where igneous ejections are piled up, coasts may be forming or currents deflected, so as to cause at these points the greatest deposit of sediment.

These considerations are sufficient to show the true value of mineral character, first as a means of distinguishing rocks of different nature and origin, and secondly of separating rocks of different ages within limited localities; with the entire worthlessness of the criterion when applied to

distinguish the ages of beds in widely separated localities. There are in America rocks as widely apart in time as the Huronian of the East and the Carboniferous of the West, which are scarcely distinguishable in mineral character: there are rocks of identical age, as for instance the Lower Silurian of New York and Western Canada and that of Nova Scotia and the North of England, which are as unlike in mineral character as it is possible for rocks of the most diverse ages to be.

But can we trust implicitly to stratigraphy? Certainly, when we find one rock directly superimposed on another we know that it is the newer of the two. But when we find old rocks slid over new ones by reversed faults, when we find sharp folds overturning great masses of beds, and when we find portions of beds hardened, altered, and become more resisting, standing up as hills in the midst of the softer materials, perhaps of the same age, which have been swept away from around them, then we have the real difficulties of stratigraphy.

We may have difficulties in fossils as well. Nothing is more common than to find in the modern ocean areas traversed by cold currents which have very different animals living in them from those in the same latitude where the water is warmer. The same thing occurs in older formations. The abundant corals and large shell-fishes in the North American limestones of the Trenton age, show a condition of things in which the great area of Central North America was covered with warm waters from the south, teeming with life, and was sheltered from the northern currents of cold and muddy water. But in the Utica shale which succeeds, we have the effect of these cold currents flowing over the same area, loading it with mud, over which lived Graptolites and old-fashioned northern Trilobites like *Triarthrus Beckii*, instead of the rich life of the Trenton. This is a mere change to a cold or glacial age, and there must have been throughout geological time not only such changes in any given locality, but areas which at the same time presented the diverse conditions of warm tropical currents and those derived from the Arctic regions, and in which consequently very different forms of animal life must have flourished.

It is only when we consider that all these causes of error embarrass the study of the Quebec group of Sir William Logan, that we can appreciate the difficulties of the case. Crossing a narrow line, a mere crack of the earth's crust, the great reversed fault of Eastern Canada and Lake Champlain, we pass at once from the flat uniform deposits of the great continental plateau of America to entirely different beds, formed at the same time along its Atlantic margin. These beds were affected by volcanic ejections, mixing them with ash rocks and causing huge earthquake waves, which tore up the rocks of the sea-bottoms and coasts, and formed great irregular beds of conglomerate, sometimes with boulders many feet in length. In the intervals of these eruptions the area was overflowed by cold Arctic currents carrying sand and mud, sometimes altogether barren of fossils, or again loaded with cold water creatures like the Graptolites

which occur in vast quantities in some of the beds. Alternating with all this were a few rare lucid intervals, when fossiliferous limestones, just sufficiently like those of the great interior plateau to enable us to guess their similar age, were being produced here and there. Farther, this heap of most irregular and peculiar deposits was that along which subsequent flexures and igneous eruptions and alterations of beds both by heat and heated waters were most rife, all the way down to the Devonian period. It is difficult without personal examination in the field to realize the actual character of the Quebec group rocks as exposed on the south side of the St. Lawrence between Point Levis and Cape Rosier. Fine black, grey and red shales are seen to alternate in the most abrupt manner with sandstones and coarse grits, and with conglomerates filled with boulders and angular stones sometimes several feet in diameter, and some of them showing evidence of neighbouring igneous ejections. These coarser beds thicken and wedge out with singular rapidity, so as often to appear as irregular masses rather than beds, while the whole formation is crumpled into sharp folds, whose complexities are aggravated by the original inequality of the beds in thickness and in resisting power. Only the conjoined action of Arctic currents bearing mud and ice and of the earthquake waves connected with the igneous action proceeding at the time to the southward, can account for such a formation.

At first the real conditions of this problem were hidden from Sir William Logan, by the error of supposing with most of the geologists of the United States, that the great reversed fault was a true stratigraphical superposition, and consequently that these strange deposits were newer than those to the west of them. But so soon as the actual nature of the case was made manifest, and this was first due to a right apprehension of the fossils, for which Mr. Billings deserves much of the credit, Sir William at once and for ever apprehended the real conditions of the problem, and set himself to work it out on the true line of investigation.

In evidence of this, and as presenting as clear a view of the whole matter as we can give, up to the present time, I quote from a note by Sir William appended to Mr. Murray's report on Newfoundland for 1865, and which is less known than his utterances on this subject published in the Canadian reports :

" The sediments which in the first part of the Silurian period were deposited in the ocean surrounding the Laurentian and Huronian nucleus of the present American continent, appear to have differed considerably in different areas. Oscillations in this ancient land permitted to be spread over its surface, when at times submerged, that series of apparently conformable deposits which constitute the New York system, ranging from the Potsdam to the Hudson River formation. But between the Potsdam and Chazy periods, a sudden continental elevation, and subsequent gradual subsidence, allowed the accumulation of a great series of intermediate deposits, which are displayed in the Green Mountains, on one side of the

ancient nucleus, and in the metalliferous rocks of Lake Superior, on the other, but which are necessarily absent in the intermediate region of New York and central Canada.

"At an early date in the Silurian period, a great dislocation commenced along the south-eastern line of the ancient gneissic continent, which gave rise to the division that now forms the western and eastern basins. The western basin includes those strata which extended over the surface of the submerged continent, together with the Pre-Chazy rocks of Lake Superior, while the Lower Silurian rocks of the eastern basin present only the Pre-Chazy formations, unconformably overlaid, in parts, by Upper Silurian and Devonian rocks. The group between the Potsdam and Chazy, in the eastern basin, has been separated into three divisions, but these subdivisions have not yet been defined in the western basin. In the western basin the measures are comparatively flat and undisturbed; while in the eastern they are thrown into innumerable undulations, a vast majority of which present anticlinal forms overturned on the north-western side. The general sinuous north-east and south-west axis of these undulations is parallel with the great dislocation of the St. Lawrence, and the undulations themselves are a part of those belonging to the Appalachian chain of mountains. It is in the western basin that we must look for the more regular succession of the Silurian rocks, from the time of the Chazy, and in the eastern, including Newfoundland, for that of those anterior to it."

In studying these rocks, as Sir William well knew that the great line of disturbance and igneous action lay to the east, as he further knew that in this belt of country, rocks all the way up even to the Carboniferous had been profoundly altered, he was not surprised to find that in tracing the Quebec rocks to the south and east, the clay slates, still holding the same fossils, became micaceous or nacreous slates, the bituminous shales graphitic slates, the limestones crystalline marble; and that even serpentine, chloritic slate and hard felspathic rocks appeared to take the place of ordinary aqueous sediments. Consequently he arrived at the large generalizations on the subject embodied in his map of Canada, and to which I believe he adhered to the last.

Was he right in these generalizations? In part, at least, it is certain that he was. Distinct Lower Silurian fossils occur in the nacreous slates and graphitic slates of the Eastern Townships of the Province of Quebec, and these slates alternate with hard quartzites, and felspathic and brecciated rocks, and so far as can be made out by stratigraphy, also with chloritic rocks, crystalline dolomite, soapstones and serpentine, these rocks seemingly representing the shales of Point Levis if not still newer members of the series. Professor Dana has shown that rocks in Connecticut, usually referred to the Quebec group, or even in the Lower Taconic series of Emmons, and often in a highly crystalline state, actually con-

tain fossils newer than those of the Quebec group, or of Hudson River age.*

Murray in Newfoundland has found the most unequivocal superposition of serpentine and chloritic slate on fossiliferous rocks of the Quebec group, and intervening in age between them and the Hudson River group. Ward has described the superposition of the Volcanic Borrowdale series on the Skiddaw slates of Cumberland, which are the undoubted equivalents of the Quebec group, and similar relations have been observed in Norway. Thus, on the one hand, there is no doubt that the Quebec group rocks, become altered in proceeding to the south and south-west, and there is nothing unprecedented in the actual replacement of some of their upper beds by volcanic or aqueo-volcanic rocks, in tracing them toward the line of the great igneous outbursts to the southward. On the other hand, taking into account the complexities of all the parts of this troubled sea of eastern Palæozoic rocks, it cannot be denied that there may exist crests of beds older than the Quebec group projecting locally and perhaps largely through these rocks. I am the more inclined to believe this, since there is the best reason to hold that the unaltered members of the Quebec group, as mapped by the Survey on the south shore of the St. Lawrence, include, as we shall see presently, beds ranging all the way from the Lower Cambrian up to the Chazy. Similar, perhaps older, beds, no doubt exist largely, mixed with igneous outflows and breccias, in the hills of the interior

But if any one thinks proper to put down a hard and fast line on the map of Eastern Canada, and to maintain that all the crystalline rocks which apparently project through and rise above the Quebec group, are of greater age, I must decline to go with him in this assertion, since it seems certain that such an extreme view cannot be in accordance with facts. No one, however, I feel persuaded, will now go so far as this; but I believe the pendulum has already swung farther than it should in this direction, and must go back again nearer to Sir William Logan's position.

At the present day these points are still subjects of discussion, and several eminent geologists are more or less inclined to dispute Sir William's conclusions. Dr. Sterry Hunt has endeavoured to show that large portions of the rocks considered by Sir William as altered representatives of the Quebec group, are of much greater age and named by him Taconian, Montalban and Huronian. Hitchcock and Macfarlane have advocated similar views, though with differences in details; while Dr. Selwyn, Sir William's successor, has been disposed to regard the altered rocks lying to the south-eastward of the typical Quebec series as belonging to two older groups.

Before discussing these new views, we may sum up Sir William's results

* American Journal of Science, 1879. One of the fossils recognized by Dana seems to be the *Stromatopora compacta* of Billings, really a *Stenopora*, known in Canada both below and above the Levis.

as they appear in his latest publications. They may be stated thus:—(1) The general diversity of mineral character in the Palæozoic sediments on the Atlantic slope as compared with the internal plateau of Canada. In these results Bailey, Matthew, and Hartt in New Brunswick, and the writer in Nova Scotia have also borne some part. (2) The establishment of the Quebec group of rocks as a series equivalent in age to the Calciferous of America, and to the Arenig and Skiddaw of England, and the elucidation of its peculiar fauna. (3) The tracing out and definition of the peculiar faulted junction of the coastal series with that of the interior plateau, extending from Quebec to Lake Champlain. (4) The definition in connection with the rocks of the Quebec group, by fossils and stratigraphy, of formations extending in age from the Potsdam sandstone to the Upper Silurian, as in contact with this group, in various relations, along its range from the American frontier to Gaspé; but the complexities in connection with these various points of contact and the doubts attending the ages of the several formations have never yet been fully solved in their details. (5) The identification of the members of the Quebec group and associated formations with their geological equivalents in districts where these had assumed different mineral conditions, either from the association of contemporaneous igneous beds and masses, or from subsequent alteration or both. It is with reference to the results under this head, the most difficult of all, that the greater part of the objections to Sir William's views have arisen.

Let us now shortly examine Dr. Selwyn's results, with reference to these conclusions, especially to the last.

The first point deserving of notice here is the inability of Dr. Selwyn to recognize in the extension of the Quebec group eastward and westward of Quebec, those subdivisions which have been named the Levis, Lauzon, and Sillery. Originally Sir William recognized two divisions only, the Levis and Sillery. Subsequently he introduced, on the ground merely of convenience, the intermediate Lauzon; though apparently not regarding the three-fold division as at all important, but merely as provisional.*

Of these subdivisions the most important is the Levis, which forms the most highly fossiliferous and most readily recognized horizon of the Quebec group, being that which has afforded the greater part of the numerous species of Graptolites described by Hall and the Trilobites described by Billings. About the precise base of this division, held to be the lowest of the group, there is some uncertainty. Sir William has referred to it as resting on Potsdam rocks in the vicinity of Lake Champlain, and farther east on older shales and limestones; and Mr. Richardson has endeavoured to separate from it certain sandstones and associated beds on the Lower St. Lawrence. More especially I may refer to the sandstones and shales near Metis, holding *Astropolithon*, *Scolithus*, and *Arenicolites spiralis*, and to beds near Matane holding species of *Conocephalites* of very primitive type.

* Report of 1866, p. 4.

In Newfoundland also, where the sequence of these beds is better seen than elsewhere, there are, according to Richardson and Billings, 2,000 feet of beds under the typical Levis and over the Lower Calciferous, holding fossils unquestionably of the second fauna of Barrande, or Lower Silurian, and below there is a great thickness of Calciferous and Potsdam. All these beds must exist in the Quebec group districts of Canada, folded up along with the Levis, and as yet very imperfectly separated from it, nor is it at all unlikely that in some localities they may have been confounded with the Lauzon and Sillery.

With regard to the distinction of these last-named formations as upper members of the Quebec group, we must agree with Dr. Selwyn that in the present state of our knowledge they cannot be clearly separated from the Levis or from one another. Nevertheless it is true that on the typical Levis there rest sandstones and shales of considerable thickness, not hold-its characteristic fossils, and forming an upper member of the Quebec group, as yet not well defined, but representing in nature the Lauzon and Sillery of Logan. It would thus appear that in addition to the rocks recognized by Sir William as Levis, Lauzon and Sillery, there must occur in the somewhat wide area of the Quebec group, rocks older than the Levis and really Cambrian in age, but not yet definitely separated from the true Quebec group. The evidence of this is farther strengthened by the occurrence of large slabs of limestone holding Cambrian fossils in the conglomerates of the Quebec group, and evidently not far removed from their original seats. Still another question has been raised as to the order of succession in the Quebec group itself. At Point Levis the limestones holding Trilobites appear to overlie the shales holding Graptolites. But while the latter are of Lower Silurian age and equivalent to those of the Arenig or Skiddaw series of England, the former present an older facies equivalent to the Lingula Flags of England. This has induced Dr. Hunt to suggest the hypothesis that these beds have actually been overturned. It is to be observed, however, that some of the Trilobites have been taken from pebbles in the lime conglomerates; and though, even making all possible allowance for this, there remain forms which may be termed Cambrian, we must farther admit that Graptolites are animals of so long life as not to fix geological horizons very minutely. Hence we may in any case regard the Levis rocks as constituting a Lower Silurian group or possibly partly transition group between the Cambrian and Silurian, and that, on the one hand, they underlie, perhaps unconformably, the Trenton series, while, on the other, they rest upon argillaceous and arenaceous beds of great thickness, as yet not perfectly separated from them and which may in part be even of Lower Cambrian age. This great series thus constitutes a thick and peculiar mass of beds, reaching from the Lowest Cambrian upward, until in its higher members it passes into beds holding Lower Silurian forms. While in the typical sections on the St. Lawrence this great series has not been fully separated into its constituent

parts, still greater difficulties attend the disentanglement of its subdivisions in its extension inland.

But again, Dr. Selwyn is disposed to separate from the Quebec group the greater part of those altered and crystalline rocks associated with it, and which appeared to Sir William Logan to be metamorphosed equivalents of this group, and largely of its upper or Sillery division. Of these rocks he forms two series, which, however, he regards as closely associated, and probably not unconformable with each other.

The first and nearest in age to the Quebec group is defined as including "felspathic, chloritic, epidotic and quartzose sandstones, red, grey and greenish siliceous slates and argillites," with "breccias and agglomerates, diorites, dolerites, and amygdaloids," as well as serpentine, dolomite, and calcite. In short this formation is one of mixed igneous and aqueous origin, non-fossiliferous, except in the case of a few microscopic fragments, and mostly crystalline. As regarded by Sir W. E. Logan, these rocks, in consequence of their apparent conformity with the Levis series, and their apparent superposition in some sections, were held to be an upper member of the Quebec group, and were mapped as Sillery. They were thus placed in the same position with the serpentine and chloritic formation of Newfoundland, as described by Murray, with the Cobequid series as I have described it in Nova Scotia,* and with the Borrowdale igneous rocks resting on the English equivalents of the Levis beds as defined by Ward in Cumberland.

Dr. Selwyn, on the other hand, thinks that the main mass of these peculiar rocks either comes out unconformably from beneath the Levis series or is separated from it by a fault, and is in all probability older, though the obscure traces of fossils found in some of the beds would indicate that they are not older in any case than Lower Silurian or Upper Cambrian.

It is obvious that with reference to a formation so greatly disturbed, either of these theoretical views may be correct, or that there may be two crystalline series, one below and another above the Levis beds.

Had Sir W. E. Logan lived, it was his intention to have, at his own cost, bored through the crystalline rocks at some selected site, in order to obtain positive proof of the subterposition of the Levis beds. The expense is not now likely to be incurred, but the whole question will in course of time be settled by the careful re-examination and mapping, which now that new views have been suggested by the head of the Geological Survey, the district ought to receive.

Dr. Selwyn's third division, supposed to be still older, possibly Lower Cambrian, in some respects resembles the second, but is predominantly slaty and quartzose, though still with dolomites and other magnesian rocks. These would naturally fall into the place assigned to them, if the age attributed to the second series be admitted, otherwise they come into

* Acadian Geology, third edition.

the period of the Sillery, or some newer formation, in an altered condition. I do not know that fossils have been found in these rocks, within the limits of Canada at least, but if they are really of Cambrian age, the richness of this fauna elsewhere in N.E. America would warrant the hope that the age assigned to them may be indicated by fossils, while, if like some similar beds to the southward, they hold Silurian species, these also must in some cases be recognizable ; so that if they finally fail to afford fossil remains or yield Lower Cambrian species, this, with their mineral character and apparent distribution, would sustain Dr. Selwyn's view; while, on the other hand, the discovery of a few distinctive Silurian forms might suffice to overturn it.

It would appear that the third and second series of Dr. Selwyn, above mentioned, are the same with the rocks which in Hitchcock's map of New Hampshire are named Montalban and Huronian. The former term has, however, been applied by Dr. Hunt to a series newer than the Huronian, called by Hitchcock the Coos group, and maintained to be distinct from the Montalban, which, however, it resembles in mineral character, and there seems to be no section showing the succession of the two supposed formations. Thus Dr. Hunt maintains that the Coos group is identical with the Montalban, while Hitchcock considers them distinct. Farther, Hitchcock regards the Coos group as Silurian, in which case the so-called Huronian and Montalban may be Silurian or Cambrian. There is thus in all this discussion no really certain advance on the position of Logan, while Dana and others, repudiating the views of Hunt and Hitchcock, still regard the greater part of these disputed crystalline rocks as representing the Quebec group, or as even in some cases newer. It is due here to Dr. Hunt to explain that he has for many years on independent grounds regarded the beds of Dr. Selwyn's second and third groups as, for the most part at least, Huronian in age, and a similar conclusion was also arrived at from comparison with the older formations of Scandinavia, by Mr. Macfarlane. Thus in one way or another all these gentlemen dissent from Sir William's conclusions, while also differing from each other, a sufficient evidence of the complicated character of the problem with which he had to deal, and whose ultimate solution may embrace elements of all the generalizations which have been put forth.

Some suggestions may at least be offered toward the solution of these questions, which deserve the attention of those who have been occupied with them. The first is that we should accustom ourselves to the anticipation that contemporaneous Palæozoic rocks in the regions of the western lakes, of the plains of Ontario and Quebec, and of the eastern slope, are not likely to be identical in mineral character. Farther, that even in the central of these three regions we may expect differences in approaching certain parts of the older rocks. At Murray Bay, for example, on the border of the Laurentian, we find the Black River limestones in great part represented by coarse sandstone, and we find similar changes in the

Chazy near Grenville. A third suggestion is, that in order to understand the eastern members of the Lower Silurian, it is necessary to be acquainted with the contemporaneous igneous ejections mixed with these rocks, and if possible to distinguish them from those of similar character so largely present in the Huronian. This is well exemplified in the rock belt of Lower and Upper Silurian age in the Acadian Provinces.* Another, to which Dr. Hunt has directed attention in his report in connection with the Survey of Pennsylvania, is the importance of inquiry as to which of the many successive movements and plications of the earth's crust occurring in Palæozoic time, have most seriously affected the now so greatly plicated and disturbed rocks of the Quebec group. Still another, and one of the most important, is the study of the various kinds of alteration which these rocks have undergone. We have in eastern Canada rocks as young as the Devonian which have been sensibly affected in this way, and there can be no doubt that large areas of the Quebec group have suffered similar changes, and that on the one hand it is possible that these metamorphosed portions have been confounded with older series, or that on the other these older series have been inadvertently mixed with them.

The value to be attached to fossils is another point of much importance. Long experience has convinced me that in the Cambrian and Silurian ages this kind of evidence is the most conclusive of all; but then it must be rightly understood. As already observed, we must discriminate the animals characteristic of the cold Atlantic waters loaded with Arctic sediment, from those of the sheltered continental plateau. We must also bear in mind that oceanic and probably floating forms of low grade, like the Graptolites, have an enormous range in time, as compared, for example, with the Trilobites, and the same remark applies to some mollusks proper to sandy or muddy bottoms, like the Lingulæ and their allies, as compared with other mollusca.

All these precautions must be taken in the study of these rocks, and it involves no depreciation of the geologists above mentioned, to say that the different conclusions at which they have arrived, depend very much on the different degrees of importance which they have attached to the various kinds of evidence accessible. To sum up, we may conclude (1) That the Quebec group of Sir William Logan constitutes a great Lower Silurian formation, extending along the east coast of North America, and corresponding in fossils, age and conditions of deposition to the Arenig and Skiddaw of England. (2) That there are associated with it beds of greater age, Menevian or perhaps even Longmynd, not yet perfectly separated from it. (3) That in their extension to the south the Quebec group rocks and those associated with them became altered and mixed with igneous ejections as well. (4) That locally ridges of still older metamorphic rocks, not yet perfectly separated from the Quebec group or

* Supplement to Acadian Geology, 1878.

from one another, project through the anticlinal folds or rise unconformably, or are brought up by faults.

One word, before closing, respecting names. These are of little importance in themselves, but it is of consequence that they should not be needlessly changed, and that they should not be misapplied.

The name "Quebec Group," introduced by Sir William Logan, should be retained for that peculiar development of the rocks of the second fauna, eminently exposed and accessible in the vicinity of Quebec, to whatever extent its extensions east and west may be circumscribed; and whatever value may be attached to the local subdivisions into Levis, Lauzon and Sillery. On the one hand, the use of one of these terms, Levis, for the whole, leads to misconception; and the absurdity of the term "Canadian" becomes apparent when we see it made correlative with a purely local name like "Trenton," and when we consider that Canada is a region greater than the United States of America, and with equally varied geological structure.

The more recent developments in the geology of North America require, as Dr. Hunt and Dr. Selwyn have urged, that the Cambrian system should be recognized as a group altogether distinct from the Silurian; and whatever views as to the use of these names may ultimately prevail in England, for us the dividing line between the Cambrian and the Siluro-Cambrian or Lower Silurian, unquestionably comes about the horizon of the Potsdam. As to the formations older than the Cambrian, I am disposed to regard the Montalban and Taconian of Dr. Hunt as representing definite groups of rocks, which may, however, eventually prove to belong to the base of the Cambrian, with which equivalent strata in the Maritime Provinces of Canada seem to be associated. The Huronian series of Logan represents another great fact in the geology of North America, namely, a period of great igneous ejection and disturbance intervening between the Laurentian and the Cambrian. In the typical Huronian area of Lake Huron it unquestionably rests unconformably on the Laurentian, and is itself overlaid by rocks of Cambrian or still greater age. It has precisely the same mineral characters and position as far east as New Brunswick and Newfoundland, and as far west as the Pacific slope,* and is thus one of the most widely diffused of American formations, though I believe it has locally been confounded with rocks of similar mineral character but of newer date. The Upper Laurentian of Logan, the Norian of Hunt, is entirely different in mineral character from the Huronian, and stratigraphically is related to the Middle Laurentian rather than to the Huronian, notwithstanding local unconformity. The Lower Laurentian of Logan may now, since the explorations of Vennor,† be safely divided into a lower and middle group,

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* Clarence King's Report of the 40th Parallel. The rugged features and precipitous sides of the Laurentian and Huronian exposures in this region correspond with Logan's view of the steep slope of the Laurentian land at the time of the deposition of the Quebec Group rocks.

† Reports Geological Survey of Canada.

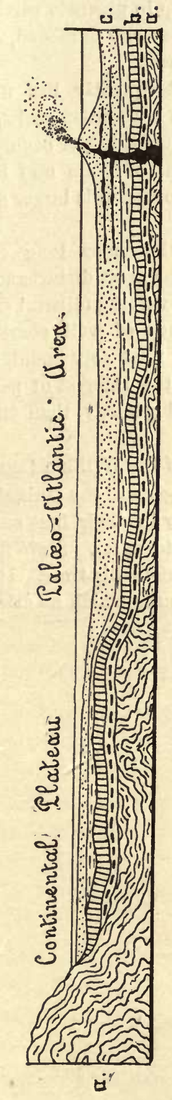
the former being, however, nothing more than the great gneissic formation recognized by Logan as the Trembling Mountain gneiss, which forms the base of his well-known Laurentian section, and the Bojian gneiss of European observers. The idea that the Middle Laurentian, the horizon of Eozoon Canadense and of the great Phosphate and Graphite deposits, is identical with the Hastings group, or with the Huronian, has, I am fully convinced, after some study of the Lake Huron, Madoc and St. John exposures of these formations, no foundation in fact. There seems, however, good reason to believe that the gap between the Lower Laurentian of Lake Huron and the Huronian, is to be filled not merely by the Middle Laurentian and the Norian, but by such rocks as those described by Dr. Bigsby, Dr. Bell and Dr. G. M. Dawson on the Lake of the Woods and other regions west and north of Lake Superior, and at present included in the Huronian, to the base of which many of them no doubt belong.*

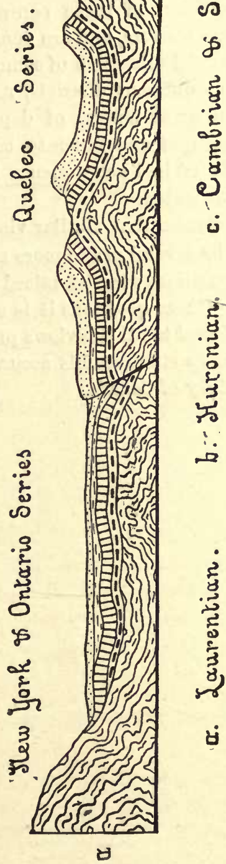
It may perhaps be well to exhibit diagrammatically, in a sectional manner, the view promulgated by Sir W. E. Logan in 1863 and 1865 with reference to the general structure of the Atlantic slope of Canada.

According to this generalization, at the close of the Cambrian age and beginning of the Silurian there occurred an elevation of the Laurentian nucleus of the American continent, which caused either an absence of deposit or the accumulation of only shallow-water beds over the great areas now occupied by Ontario, New York and part of Quebec, while thick deposits were formed in deeper water on the Atlantic border of the continent and in the Lake Superior region. Hence the great lithological difference between the Cambrian and lowest Silurian beds in the east and west as compared with their representatives in the central region. This difference and its causes are represented in ideal Section No. I. In connection with this it is proper to observe: (1) That disturbances anticipatory of this state of things had begun in the Huronian age, and are indicated by its unconformability to the Laurentian, and by the igneous products included in it. (2) That extensive igneous outbursts occurred at the margins of the sea areas, both in the east and west, in the Cambrian age, as indicated by the Keweenian volcanic rocks in the west, and by the conglomerates with volcanic fragments and evidences of violent wave-action in the Quebec group of the east.

Early in the Silurian period there followed on the previous unequal elevation one of the great crumplings of the crust of the earth, which crushed the thick and soft deposits of the Atlantic area against the edge of the inland Laurentian area, producing foldings, flexures and faults of the Atlantic rocks, but leaving the thinner layers deposited upon the upraised plateau comparatively undisturbed. In this way the state of things represented in Section II. was produced. Thus the beds of the typical Quebec series, which represent the Atlantic deposits laid down in

* G. M. Dawson's Report on 49th Parallel. Bell, Reports Geological Survey of Canada.





a. Laurentian. b. Huronian. c. Cambrian & Silurian.

comparatively deep and cold water, were thrust against the flat beds of the inland Potsdam and Calciferous and piled up in gigantic earth-waves. At the same time these crumpled beds were necessarily hardened, rendered slaty and otherwise modified by pressure and heat.

Lastly, the denudation which occurred subsequently has no doubt exposed in places the older Huronian and even Laurentian rocks, thrown up in the axes of the folds. The extent to which this has occurred is in reality the main point in dispute between Sir William and his later critics, whose new views in no respect otherwise affect his larger generalizations as above stated.

The discussion of these controverted questions may long continue. The facts are obscure, and are complicated by the great disturbance of the beds, the partial alteration of some of them, the varying mineral character of others in different districts, and the absence of well characterized fossils from great masses of deposits. Their final settlement, though locally important and much to be desired in the interest of geological mapping, is of less consequence to theoretical geology than the broad views above stated.

It is not denied that similar views to those of Sir William Logan have been held by several of the more eminent geologists of the United States, and that questions may be raised as to priority in their first announcement. Into these questions it is not necessary to enter. Sir Wiliam has himself referred to all the views promulgated before his time. It is only desired here to vindicate his accuracy in the results which he attained as to the Geology of Canada.

APPENDIX B.

LIST OF SIR WILLIAM LOGAN'S MORE IMPORTANT PAPERS, REPORTS, &c.

On the Character of the Beds of Clay lying immediately below the Coal-seams of South Wales, and on the Occurrence of Coal Boulders in the Pennant Grit of that District.—Trans. Geol. Soc., 2d. Ser., VI., 1842, p. 491.

On the Packing of Ice in the River St. Lawrence ; on a Landslip in the Modern Deposits of its Valley ; and on the Existence of Marine Shells in those Deposits, as well as upon the Mountain of Montreal.—Proc. Geol. Soc., III., 1842, p. 766.

On the Age of the Copper-bearing Rocks of Lakes Superior and Huron, and various facts relating to the Physical Structure of Canada.—Proc. Brit. Assoc., 1851 ; Am. Jour. of Sci., 2d. Ser., XIV., p. 224.

On the Occurrence of a Track and Foot-prints of an Animal in the Potsdam Sandstone of Lower Canada.—Quart. Jour. Geol. Soc., VII. 1851, p. 247.

On the Foot-prints occurring in the Potsdam Sandstone of Canada.—Quart. Jour. Geol. Soc., VIII., 1852, p. 199.

On the Physical Structure of the Western District of Upper Canada.—Can. Jour., III., 1854-5, p. 1.

On the Division of the Azoic Rocks of Canada into Huronian and Laurentian.—Can. Nat., II., 1857, p. 255 ; Can. Jour., N.S., II., 1858, p. 439.

On the probable Sub-division of the Laurentian Rocks of Canada.—Can. Nat., II., 1857, p 270 ; Can. Jour., N.S., III., 1858, p. 1.

Relative Dates of various Intrusive Rocks cutting the Laurentian Series in Canada.—Can. Jour., N.S., III., 1858, p. 107

On the Track of an Animal lately found in the Potsdam Formation.—Can. Nat., V., 1860, p. 279 ; Am. Jour. Sci., 2d. Ser., XXXI., p. 17.

Remarks on the Fauna of the Quebec Group of Rocks, and the Primordial Zone of Canada, addressed to Mr. Joachim Barrande.—Can. Nat., V., 1860, p. 472 ; Can. Jour., N.S., VI., 1861, p. 46 ; Am. Jour. Sci., 2d. Ser., XXXI., 1861, p. 216.

Considerations relating to the Quebec Group and the Upper Copper-bearing Rocks of Lake Superior.—Can. Nat., VI., 1861, p. 199.

On the Rocks of the Quebec Group at Point Levis (Letter addressed to Barrande, March 15th, 1863).—Can. Nat., VIII., 1863, p. 183.

On the Geology of Eastern New York. By Professor James Hall and Sir W. E. Logan.—Can. Nat., N.S., I., 1864, p. 368.

On the Occurrence of Organic Remains in the Laurentian Rocks of Canada.—Quart. Jour. Geol. Soc., XXI., p. 45 ; Can. Nat., N.S., II., 1865, p. 92.

On new Specimens of Eozoon.—Quart. Jour. Geol. Soc., XXIII., p. 253 ; Can. Nat., N.S., III., p. 306.

GOVERNMENT REPORTS

Report of Progress to 1843. Published Montreal, 1845. This was the first of the regular Reports of Progress published after the appointment of Logan as Provincial Geologist, and gives a general notice of the Geology of Eastern and Western Canada so far as then ascertained. It is premised by "Remarks on the Mode of making a Geological Survey of Canada," and by a short "Preliminary Report." Logan's celebrated section of the measures at the Joggins is given as an Appendix, and occupies about sixty pages.*

Report of Progress for 1844. Published Montreal, 1846. Contains Logan's topographical surveys of the Chatte and Cascapedia Rivers, and an account of the geology of a large part of the Gaspé Peninsula. An Appendix of thirty-three pages contains a section of the coal measures on the south side of the Baie des Chaleurs, and various detailed sections of the Gaspé sandstones.

Report of Progress for 1845-6. Published Montreal, 1847. Contains Logan's surveys of the Ottawa River and Lake Temiscamang, and a description of the Geology of the Ottawa Valley.

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* This and the following volumes contain, in addition to Logan's Reports, those of the various members of his staff. For particulars concerning them see "List of Publications of the Geological Survey of Canada," prepared by the writer and published in 1879.

Report of Progress for 1846-7. Published Montreal, 1847. Contains a description of the geology of the north shore of Lake Superior.

Report of Progress for 1847-8. Published Montreal, 1849. Contains a description of the geology of the Eastern Townships.

Report of a Geological Exploration of Part of the North Shore of Lake Huron, made in 1848. Published Montreal, 1849.

Report of Progress for 1849-50. Published Toronto, 1850. Contains an account of a geological examination of St. Paul and Murray Bays, and of portions of the south side of the St. Lawrence.

Report of Progress for 1850-51. Published Quebec, 1852. On the gold of Eastern Canada.

Report of Progress for 1851-2. Quebec, 1852. Contains a description of the geology of the Counties of Beauharnois and Lake of the Two Mountains; also a notice of the London International Exhibition and of the Canadian minerals exhibited there.

Report of Progress for 1852-3. Quebec, 1854. Contains a geological description of the north shore of the St. Lawrence between Montreal and Quebec, with details concerning economic minerals.

Report of Progress for 1853-56. Toronto, 1857. Contains a description of the Laurentian rocks of the Ottawa and the economic materials found in them. Also remarks on the preparation of a geological map of Canada.

Report of Progress for 1857. Toronto, 1858. Contains remarks by Logan on the various labours of the Survey.

Report of Progress for 1858. Montreal, 1859. Contains Logan's topographical survey of the Rouge, with descriptions of the Laurentian limestones; also details concerning the Ramsay Lead Mine, the Acton Copper Mine and miscellaneous economic minerals.

Geology of Canada; Report of Progress of the Geological Survey from its Commencement to 1863. A large octavo of 983 pages (*Vide ante*, p. 350.) The Atlas accompanying the Geology of Canada contains Sir William's beautiful map showing the distribution of the Laurentian rocks of the Grenville region.

Report of Progress, 1863-66. Ottawa, 1866. The introductory Report of this volume is by Sir William Logan, and refers to the geological work of the Survey in the Eastern Townships, on the Ottawa and elsewhere, as well as to the subject of *Eozoon.*

Report of Progress, 1866-69, A short "Summary of Geological Investigations." Ottawa, 1869.

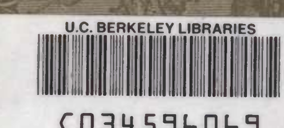
Sir William's large Geological Map is a work which cost him a great deal of thought, time and toil. Not satisfied with giving the results obtained by his own Survey in the Provinces of Upper and Lower Canada, he determined to include the geology of the British Maritime Provinces and of the Northern United States. In this latter work of compilation he had the cordial co-operation of Professor James Hall, Dr. Dawson and other geologists, whose assistance he fully acknowledged.

END.

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